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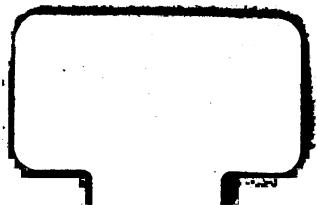
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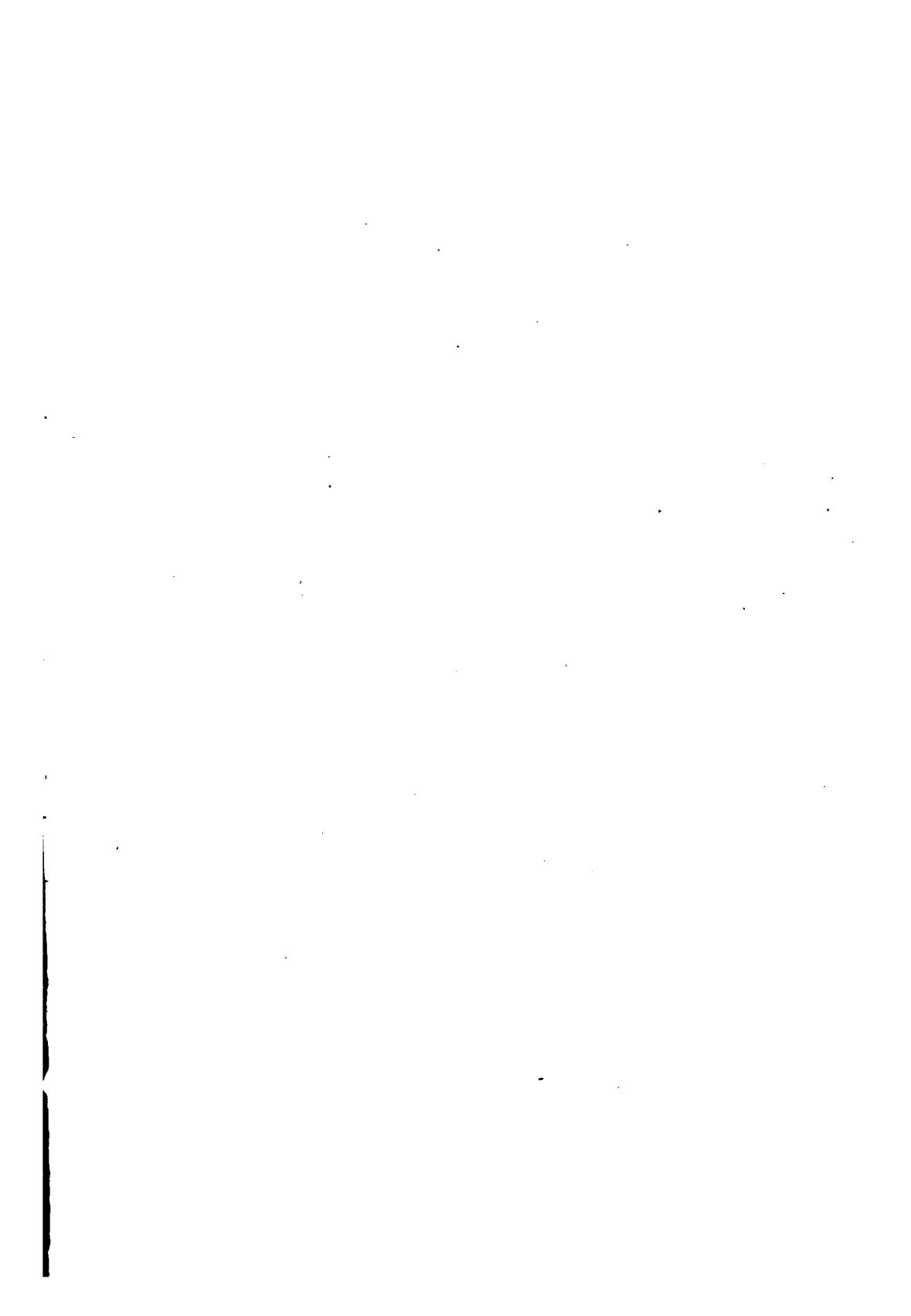
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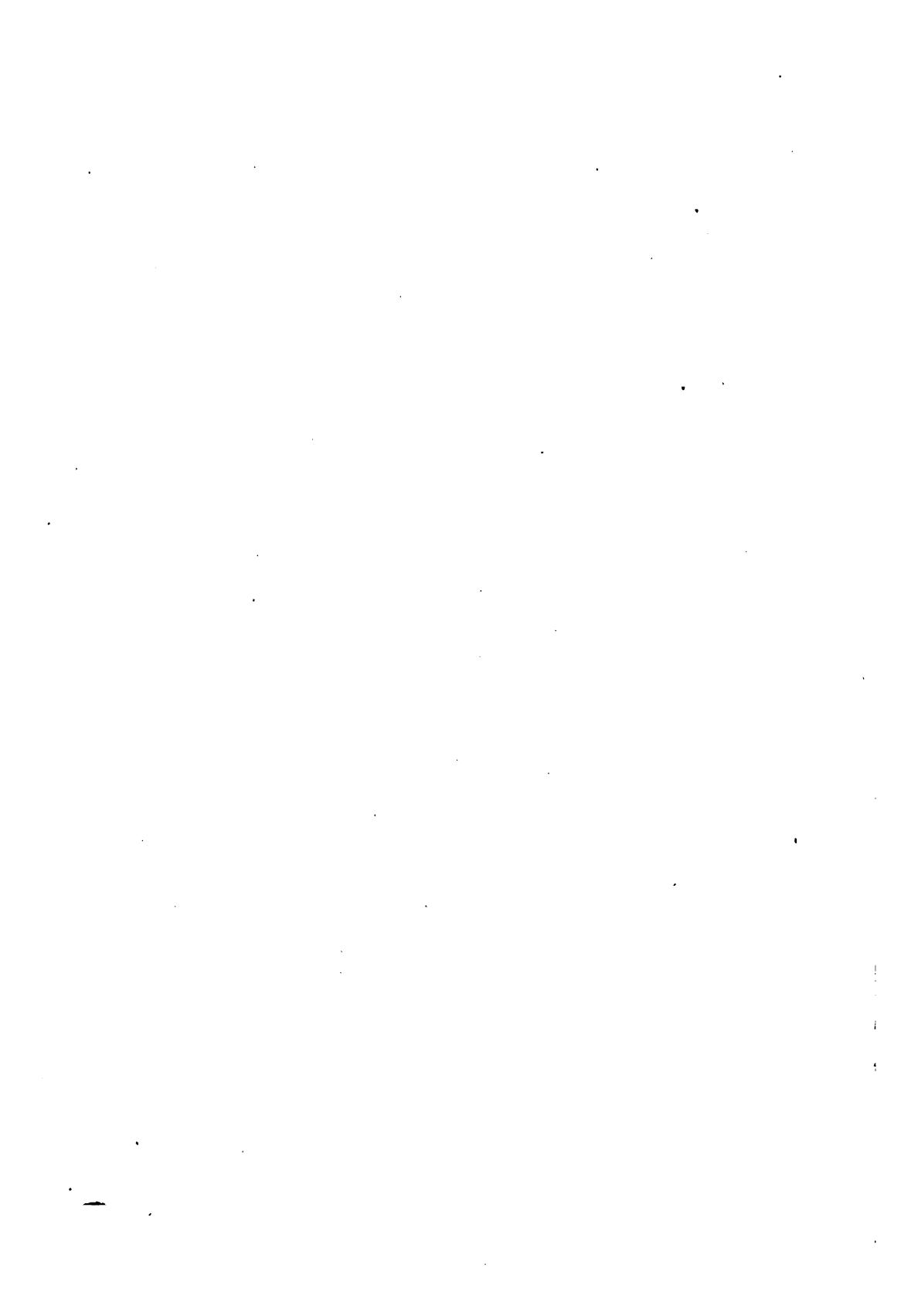
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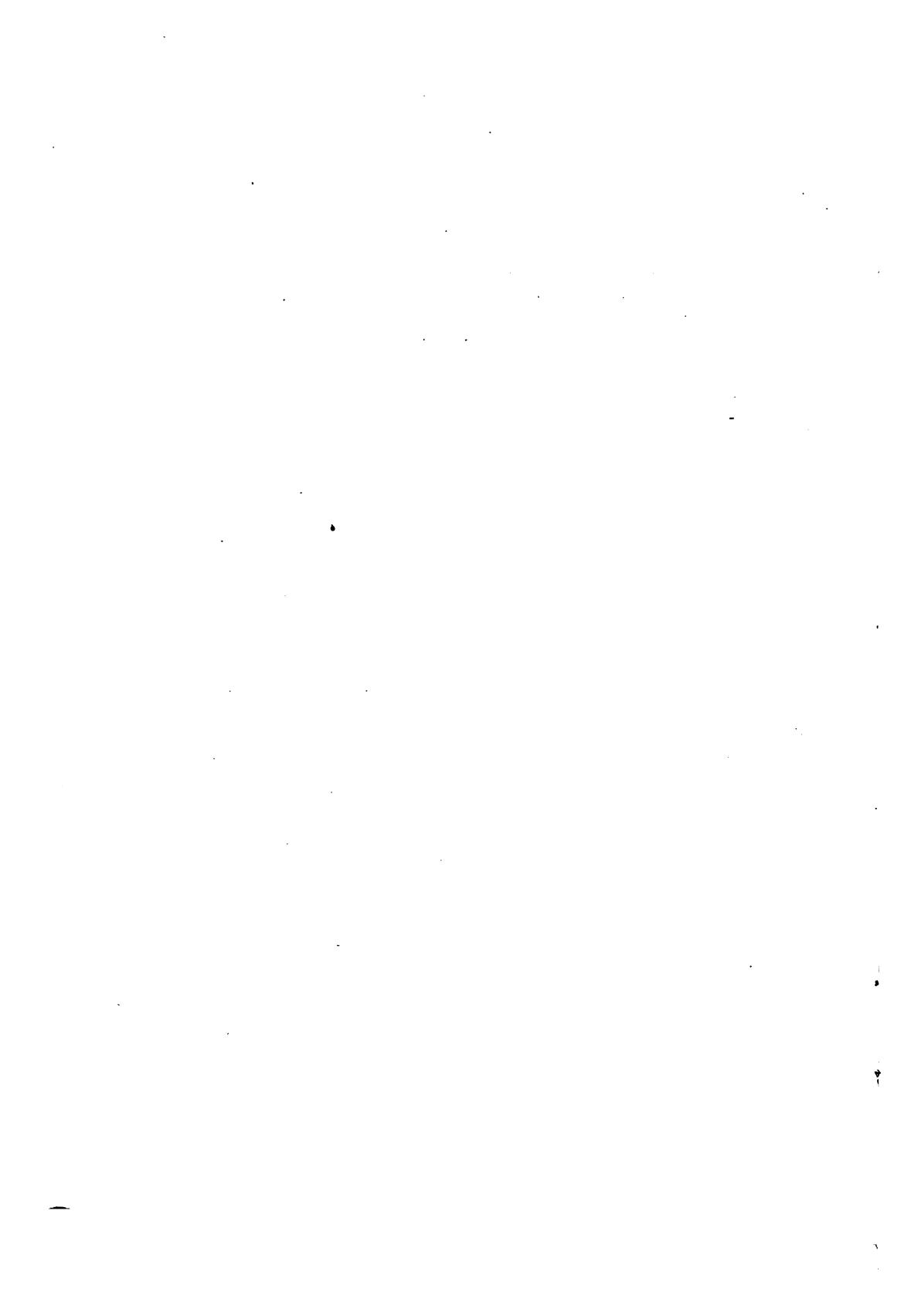
INTERNATIONAL HEALTH BOARD

SIXTH ANNUAL REPORT

January 1, 1919—December 31, 1919

61 Broadway, New York, N. Y., U. S. A.

1920



Public Health
8th
Dr. Henry J Vaughan
10-16-47

INTERNATIONAL HEALTH BOARD

Report of the General Director

To the President of the Rockefeller Foundation:
Sir:—

I have the honor to submit herewith my report as General Director of the International Health Board for the period January 1, 1919, to December 31, 1919.

Respectfully yours,
WICKLIFFE ROSE,
General Director.

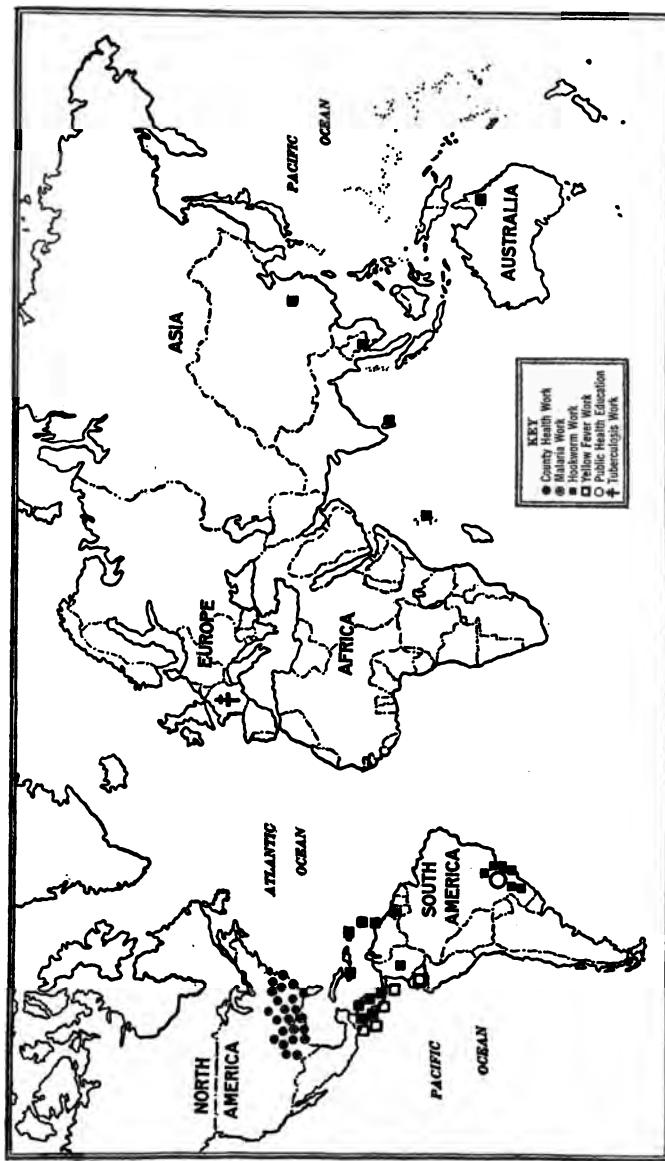


FIG. 1.—World map of activities of International Health Board

INTERNATIONAL HEALTH BOARD

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SIMON FLEXNER
FREDERICK T. GATES
WILLIAM C. GORGAS¹
STARR J. MURPHY
JOHN D. ROCKEFELLER, JR.
WILLIAM T. SEDGWICK
VICTOR C. VAUGHAN
WILLIAM H. WELCH

EDWIN R. EMBREE, *Secretary*

¹Deceased July 4, 1920

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VICTOR G. HEISER, M.D., *Director for the East*
HECTOR H. HOWARD, M.D., *Director for the West Indies*
W. PERRIN NORRIS,* M.D., *Associate Director for the East*
L. W. HACKETT, M.D., *Associate Regional Director (for Brazil)*
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BRITISH GUIANA	F. W. Dershimer
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CHINA	F. C. Yen* J. B. Grant
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JAMAICA	W. T. Burres
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NICARAGUA	P. B. Gardner
NORTH CAROLINA	P. W. Covington
PANAMA	D. M. Molloy B. E. Washburn F. A. Miller

†Personnel employed by Government in co-operative work not listed

*Special Staff Member

INTERNATIONAL HEALTH BOARD

ix

SALVADOR	C. A. Bailey
SEYCHELLES	J. F. Kendrick
SIAM	M. E. Barnes
TRINIDAD	G. C. Payne R. B. Hill

MALARIA

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YELLOW FEVER

YELLOW FEVER COMMISSION

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T. C. Lyster*
W. Pareja*
Hideyo Noguchi*
Israel Kligler*
W. D. Wrightson*

ECUADOR	M. E. Connor
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TUBERCULOSIS

TUBERCULOSIS IN FRANCE

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Alexandre Bruno*
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X

THE ROCKEFELLER FOUNDATION

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IN TRAINING

F. C. Caldwell

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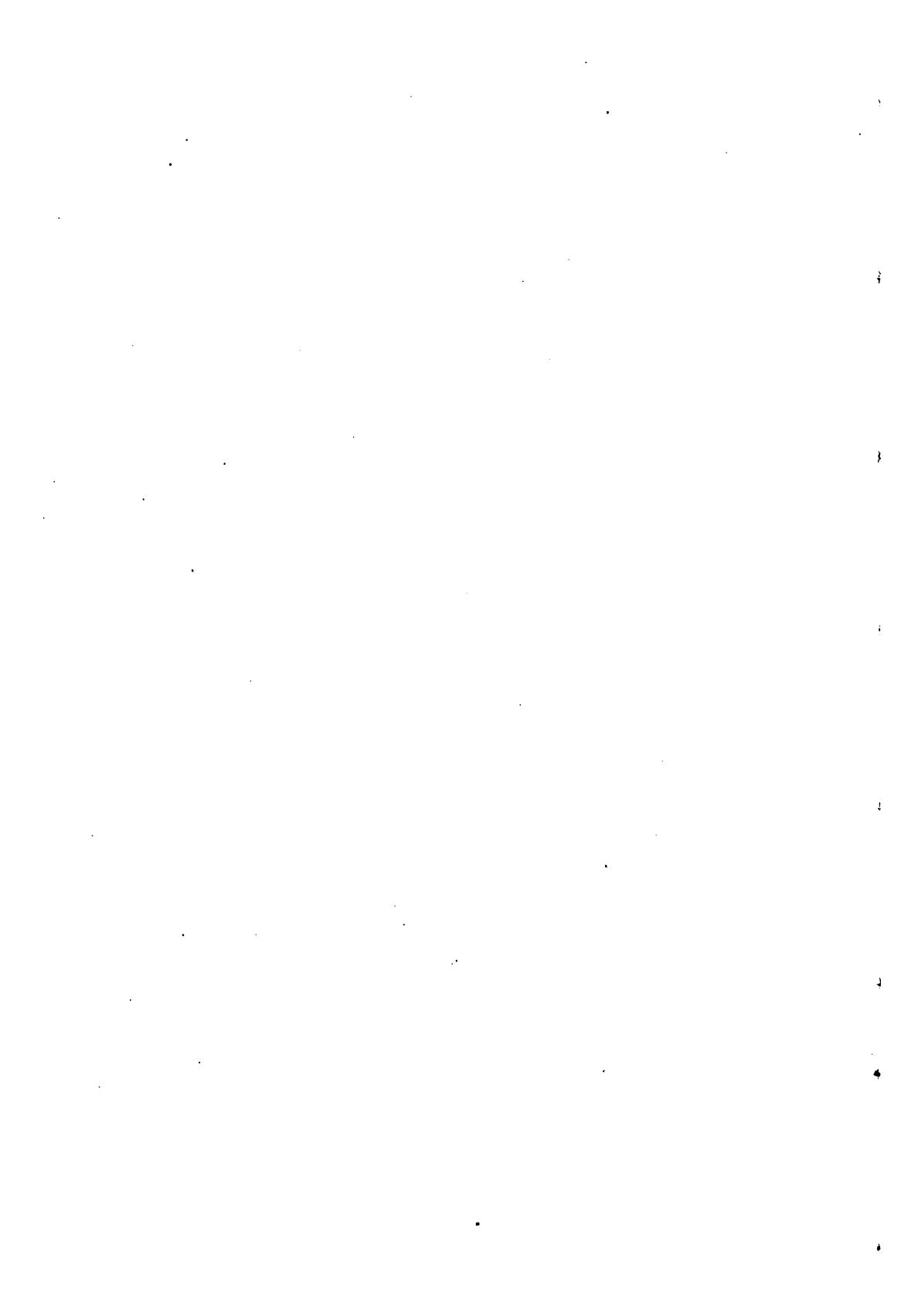
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INTERNATIONAL HEALTH BOARD

The work of the International Health Board began in the year 1914 with the extension into foreign lands of the measures for the control of hookworm disease which had been under way for a number of years in the Southern States of the American Union. The first of these foreign countries was British Guiana. Each succeeding year has been marked by a steadily widening range of operations. Governments in all parts of the world have invited the Board to enter with them into crusades for better health. In response to these requests, hookworm demonstration campaigns have been organized in Central and South America, in Europe, Asia, and Australia, and in the West Indian and South Sea Islands. Meanwhile the work in the United States has been continued and expanded.

Extension of Activities

The regular co-operative program of the Board was enlarged during the year 1919 to include the activities enumerated on pages 2, 3, and 4. During recent years, in addition, the Board has been more and more frequently called upon to participate in public health and related matters, and to furnish information bearing on these topics. Cities, towns, states, and countries, as

well as public or semi-public organizations and officials, are availing themselves of the facilities which the Board has to offer. Service of this kind is in keeping with the established policy of the Board: namely, to co-operate with governments throughout the world in demonstrating the feasibility and economic value of preventive measures against disease, and thus to aid in creating, in the various countries, popular interest in and support for public health work.

Main Features of the 1919 Work

All of the work during the year 1919, as in preceding years, was conducted in close association with governmental agencies. The activities enumerated below were the chief features of the program:

1. Demonstrations in malaria control through anti-mosquito measures were continued in ten towns in Arkansas.
2. A program was developed, surveys were made, and a staff was recruited for extending the Arkansas type of demonstrations in malaria control (through anti-mosquito measures) to nine additional southern states.
3. Further research into the problem of malaria control through anti-mosquito measures at scattered farm homes was conducted in Hinds county, Mississippi. Special studies were made of the top minnow as a means of preventing mosquito-breeding.

4. Investigation of the feasibility of controlling malaria through the treatment of carriers was continued, under slightly varying conditions, in Sunflower county, Mississippi.
5. Systematic efforts to eradicate yellow fever from Guayaquil, Ecuador, proved successful.
6. Outbreaks of yellow fever infection in Nicaragua, Honduras, and Salvador were suppressed.
7. The etiology of yellow fever was subjected to further scientific study.
8. Plans were matured for a comprehensive attack on yellow fever in its remaining endemic centers.
9. The campaign against tuberculosis in France was extended.
10. Measures were continued for the control of hookworm disease in twelve southern states and in sixteen foreign states or countries.
11. Anti-hookworm measures were begun in four new fields: the state of West Virginia, the island of Jamaica, and the states of Minas Geraes and Paraná in Brazil.
12. Operations under a new public health program were begun in Australia.
13. Preliminary hookworm infection surveys were completed in the states of Minas Geraes and Paraná (Brazil), and at the mines and shipping terminus of the Tayeh Iron and Steel Works in China.
14. Preliminary hookworm infection surveys were undertaken in the states of Maranhão and Santa Catharina (Brazil), in Porto Rico, and in Colombia, South America.
15. The work looking toward the control of hookworm infection at the Pinghsiang Colliery, as a means of

entering the public health field in China, was completed.

16. The Board's staff members at the Department of Hygiene of the Faculty of Medicine, University of São Paulo, Brazil, made valuable field studies in hookworm disease.
17. Studies in public health organization were made
18. Participation in county health demonstrations in the Southern States was extended.
19. Staff members were lent for special service.
20. Public health fellowships were provided and an organization was developed for selecting persons qualified to receive the grants.

Betterment of Rural Health Conditions

The evolution of simple hookworm posts into effective agencies for conserving public health has been one of the gratifying developments in the Southern States. A county health service with a whole-time health officer at its head has been a goal that has been won for many communities. Demonstrations to show effective methods of relieving hookworm disease gave great impetus to appropriations for health work in general, and led indirectly to the strengthening of state and county health departments. The public began to see that even with modest expenditures of money, disease could actually be prevented.

Plan of Work Pursued by County Health Departments

At the present stage the work essentially provides: (1) an education for every citizen in the fundamentals of health preservation; (2) an accurate health survey of the county as a whole; (3) a health map locating every home, with symbols to show the diseases that have occurred at each home during the past five years; (4) the medical inspection of every school child, with treatment for those who require it; (5) examination for hookworm disease and treatment of the infected; (6) a fly-proof latrine at every home, to prevent soil pollution and its attendant diseases, such as hookworm disease, typhoid fever, diarrhea, and dysentery; (7) infant welfare work; (8) free typhoid and smallpox vaccination; and (9) the establishment of a permanent health department.

There are minor differences in the work which the county health departments conduct in the different states. In North Carolina, life extension work, which contemplates the early detection and treatment of diseases of adult life; the quarantine of infectious diseases; the prevention of tuberculosis; and free dental clinics, are included among the activities undertaken. In some of the states the various activities are not prosecuted simultaneously, but are taken up in

turn. Sometimes the health department centers its energies during the first year of its organization on the prevention of soil pollution, quarantine, and the medical inspection of school children. No rigid order is adhered to in carrying out the different features of the program, but each activity is stressed in turn and each is taken up when the time seems opportune and the conditions favorable for its success.

One of the most valuable features of the work in all the states is the county health survey. This gives the state and county health departments a record of all infections within the county and a clinical history of each individual. The survey includes particulars as to hookworm, malaria, typhoid fever, tuberculosis, and other communicable diseases. In each state the co-ordination of the separate county health departments is effected through a central bureau of county health work, which is located at the headquarters of the state board of health and forms an integral part of that body.

Extent of County Health Work at Close of 1919

North Carolina is among the leaders in county health work. Beginning there in June, 1917, with the organization of a department of health for the county of Wilson, the work has since grown and developed until at the end of 1919



Fig. 2.—Motor clinic used in rural health work, Lee county, Mississippi



Fig. 3.—Side view of rural motor clinic, Fig. 2



Fig. 4.—Dental clinics at rural schools. A prominent feature of county health work in North Carolina

the state had twenty-four counties, embracing 38 per cent of its total population, under whole-time health officers. In fourteen of the counties health departments had been established. To stimulate the county health plan, especially during the formative period, the Board had co-operated with ten states by the end of 1919 in the development of their programs.

Benefits of County Health Work Appreciated

In the state of North Carolina the four most striking effects of the co-operative plan of county health work have been the decrease in the death rate from soil pollution diseases, the steady increase in the number of counties providing for whole-time county health officers or county health departments, the new and progressive health legislation enacted in 1919 by the General Assembly of the state, and the widespread recognition by state, county, and municipal officers, by business men, and by the public in general, of the value of the work. The genuine

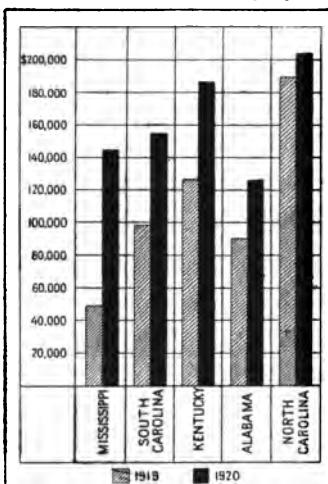


Fig. 5.—Appropriations of legislatures to State Boards of Health for health work exclusive of tuberculosis. Five southern states. 1919 compared with 1920

interest and confidence are further attested by the ever increasing amounts which the legislatures are appropriating for the work. As an instance may be cited the appropriations recently made by the states of Mississippi, South Carolina, Kentucky, Alabama, and North Carolina. Fig. 5 compares, for the five states, the appropriations for health work (exclusive of tuberculosis) for the years 1919 and 1920. The Kentucky legislature has created a special fund for continuing state aid to counties or districts which establish or maintain departments of health, and has authorized the state auditor to draw a warrant in favor of the state board of health for \$2,500 annually for each county which has established a health department.

Rural Sanitation in Brazil

In a number of other countries a similar evolution is taking place. Interest in rural public health work is becoming nation-wide in Brazil. From all parts of the country the Federal Government is being besieged with requests to increase its participation in rural health activities. As a result, it has matured plans for a comprehensive program providing for the organization, with government assistance, of rural sanitary services throughout the republic. During 1919 the states of Rio de Janeiro and Santa Catharina



Fig. 6.—Typhoid vaccination day at schoolhouse in Pine Grove community, Jackson county, Mississippi. One old gentleman said that day, "Doc, you cured us of the terrible hookworm and stamped out smallpox, and now you are stamping out the slow fever. We want all the good things you've got or can get!"



Fig. 7.—Conference of county health officers, state of North Carolina

organized such services with the aid of the Federal Government and of the Board. Their programs include, as the central feature, treatment and control measures for hookworm disease. The plans call also for an attack on other rural disease problems, more especially those presented by malaria.

Development of Public Health Activities in British Guiana

In March, 1914, a co-operative campaign for the control of hookworm disease was inaugurated in British Guiana. With this campaign began a movement for improved sanitation, especially that directed toward the control of soil pollution diseases. For five years, demonstrations in hookworm control, educational work, and efforts to secure sanitary improvement were carried on in numerous villages and rural areas. These operations, however, were greatly hampered by war conditions, and a full realization of the aims of the campaign was of necessity delayed. But throughout this period a leaven was at work, a way was being charted. By the early part of 1919 the results of these years of effort began to make themselves felt. It became evident that British Guiana had caught the spirit of public health reform and had awakened to the need for a wide-spread regulation of the conditions of life with a view to the health and well-being of

the people. In February, the sugar planters of the colony asked Government to extend to their laboring forces the benefits of hookworm treatment and to co-operate in providing proper sanitary conveniences on the plantations and in the surrounding villages. Government promptly adopted a practical working program toward this end and appropriated \$100,000 yearly for five years toward carrying it out.

The organization of a sanitary department is now well under way. In addition to the chief sanitary officer, there are on the staff at present¹ one assistant, three county sanitary inspectors, four district sanitary inspectors, two government disinfecting assistants, and three clerical assistants. The chief officer, his assistant, and the seven inspectors have been trained in England. Each year there are to be added three or more district sanitary inspectors similarly qualified. In addition to these developments \$10,000 was devoted to the sanitary department for special intensive sanitary work; one estate has built a model village in which to house its labor; many other estates are improving their housing facilities and putting in latrine systems and similar conveniences; and the city of Georgetown is planning to install both a modern system

¹ May, 1920

of sewage disposal and a piped water supply. A committee appointed by Government to report on colony drainage is now at work. A conservative estimate of the amount that will be spent in the colony during 1920 by Government, municipalities, and private interests, for the purpose of combating disease and dealing with such problems as drainage, sewage disposal, and water supply, places the sum well in excess of \$200,000. And the work contemplated promises to be of a permanent, substantial character shaped along safe and conservative lines.

Scoring Health Activities

With the rapid increase in the amounts set aside for health work in the various states and countries has arisen a real need for some measure of the value of the results obtained by expenditures for this work. It is not the amount which a state expends in health activities that is of importance, but the kind of trade which it makes—what it obtains for the expenditure. As a means of arriving at an approximate evaluation of the public health operations under way in North Carolina, Dr. W. S. Rankin, State Health Officer, has drafted a plan of scoring, in terms of financial return to the people, the various health measures in operation throughout the state. This scoring method assigns to each

health activity a relative money value. For example, each sanitary latrine is scored as having a value to the community of \$5.00, each hookworm treatment as having a value of \$2.00, and each life extension examination as having a value of \$5.00. The total score for all the health activities of the state during the year 1919 showed an estimated return to the people of \$1,791,210.00 as a result of the expenditure by the State Board of Health of \$437,677.00.

This method of evaluating health measures by showing the return for each dollar expended should be of great aid in stimulating the populace and the officials of the state to an increased interest in health work. It is probable, moreover, that the plan will be adopted by other states and countries and that a measure of comparison will thus be provided which should make for a spirit of friendly rivalry conducive to a rapid and wholesome growth in health activities.

Extension of Malaria Control Program

During the four-year period from 1916 to 1919 inclusive, the Board, in association with governmental agencies, was engaged in a series of field studies in malaria control. These studies were intended to determine the relative efficiency, economy, and feasibility of different methods under various conditions. Certain of

the experimental campaigns have been attended with a large measure of success. They have shown that by simple anti-mosquito measures malaria can be controlled in the average small town of the Southern States at a cost well within

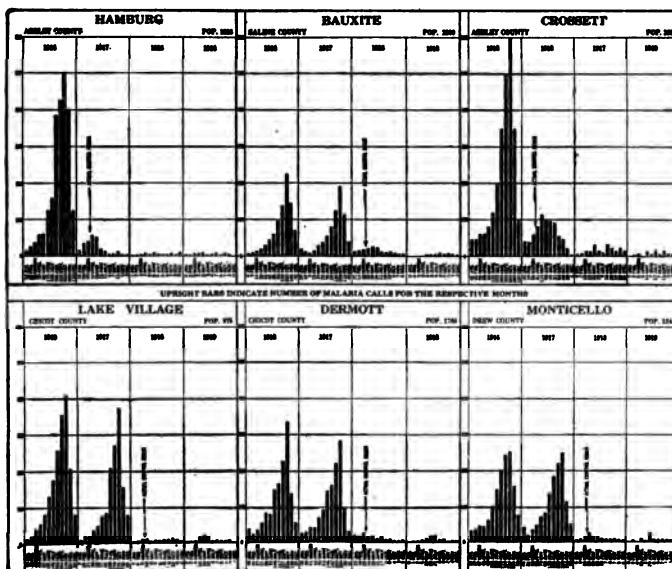


Fig. 8.—Record of malaria control in six Arkansas towns, 1916-1919

the means of the community. And furthermore they have proved that the introduction of anti-malaria measures is economically desirable, in that the results more than justify the expenditure involved. The extra-cantonment anti-malaria measures conducted upon an immense scale by the United States Public Health Service

further emphasized and confirmed the results of the previous studies.

The success of the foregoing control demonstrations led the state boards of health of ten southern states, in association with the United States Public Health Service, selected towns, and the International Health Board, to conduct surveys during 1919 and to adopt a program calling for the organization of demonstrations of a similar nature in a number of towns within the several states. Present plans provide for experimental demonstrations during 1920 in four or more towns in each state. It is hoped that these more extensive field operations will confirm the results of the earlier investigations and lead to the organization of state-wide crusades against a disease which has long been a serious menace to life, health, and economic progress throughout the South.

Stamping Out the Seed-Beds of Yellow Fever

The program for the attack on yellow fever in its remaining endemic centers has been kept steadily in mind. The disease, after being present in Guayaquil for more than a hundred years, was brought under complete control in May, 1919. Notwithstanding this favorable showing, it was considered advisable to continue anti-mosquito measures throughout the year.

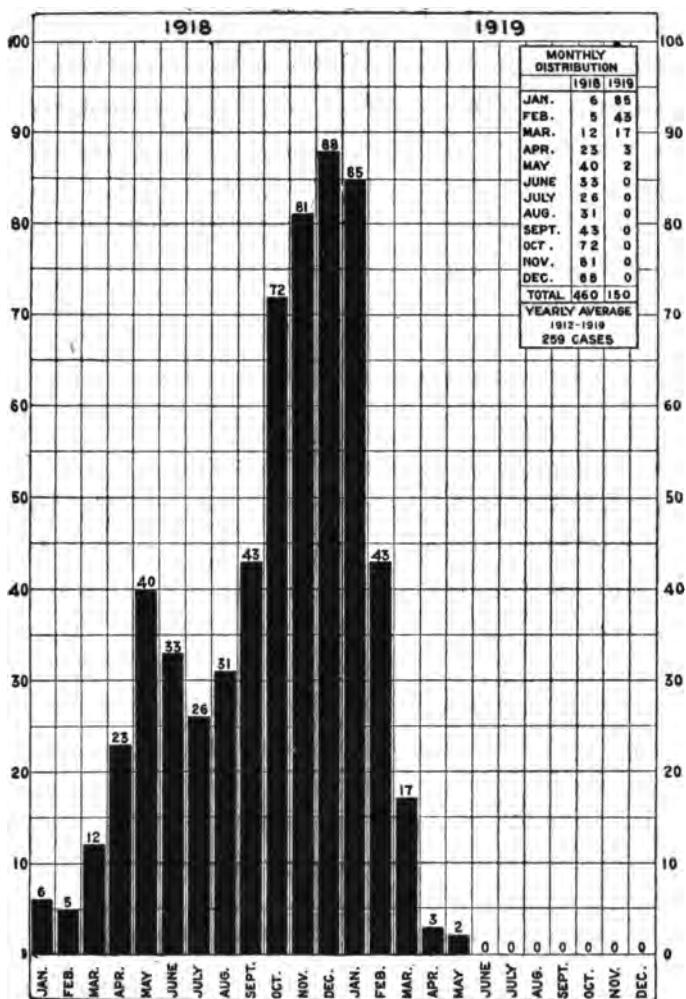


Fig. 9.—One step in the eradication of yellow fever. Disappearance of the disease from Guayaquil, Ecuador, as result of control measures

There still remained the possibility that the disease might be re-introduced from neighboring countries. During the year 1919, outbreaks of yellow fever occurred also in Central America. They were not regarded as likely to create new endemic centers, but for humanitarian reasons the Board gave, upon request, active aid in suppressing them.

Yellow Fever Organism, Vaccine, and Serums

The suggestive spirochete isolated by Noguchi in Guayaquil was further studied by him and his co-workers in Merida, Yucatan, during 1919 and in Peru during the early part of 1920. As a result of this work and of further laboratory studies, it has now become reasonably certain that the organism which Noguchi named *Leptospira icteroides* is the true etiological agent. Vaccine and serums made with the organism are protective in animals, and while their use in human beings has been limited there is much evidence that they have real value.

Countries Visited by Yellow Fever During 1919

The disease was reported during 1919 from Peru and Brazil in South America, from Honduras, Salvador, and Nicaragua in Central America, and from Mexico. Upon the request of the Central American countries, a trained

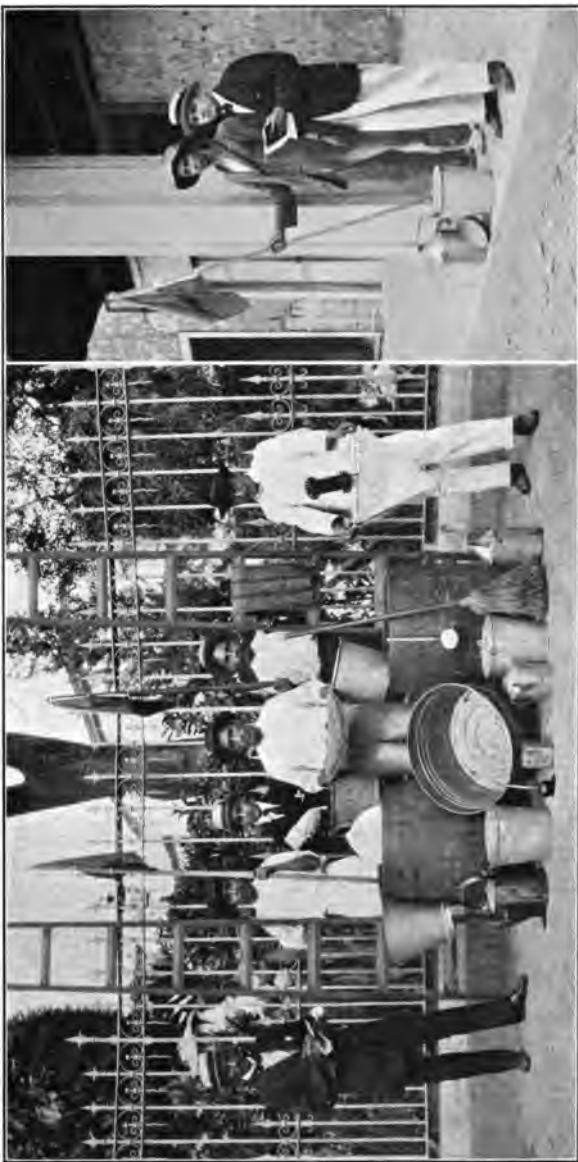


Fig. 10.—Simplification of apparatus and reduction in size of squads. Yellow fever control measures in Guayaquil. December, 1918, and December, 1919



Fig. 11.—Type of tank used for storing water in the municipality of Guayaquil, Ecuador. The solution of the problem of yellow fever control depended very largely upon the prevention of breeding in such tanks. They were fitted with zinc covers and sealed to prevent access of mosquitoes

field force was made available and in the course of a few months the disease was confined to a small number of sporadic cases in Salvador. Until the smouldering flames in the true endemic centers in Mexico and Brazil can be extinguished, local conflagrations caused by sparks of the permanent fires must be expected to occur.

Visit of Inquiry to West Africa

Arrangements for sending to the west coast of Africa a mixed commission, with General Gorgas at its head, to study the disease which in that region is regarded by many as yellow fever, were completed during 1919 with the British and other interested governments. The fact that Noguchi's spirochete has been definitely associated with yellow fever should afford this commission a better opportunity than has heretofore existed for studying the etiology of the disease.

Tuberculosis Work in France

Throughout its two and one-half years of work, the Board's Commission for the Prevention of Tuberculosis in France has directed its efforts toward the realization of a three-fold aim: to demonstrate that tuberculosis, which claims so vast a toll of lives each year, is a curable and preventable disease; to establish a standardized

program for the control of the infection and to secure its uniform operation by government agencies throughout all departments of the country; and to effect the centralization of volunteer anti-tuberculosis work in the hands of a national association, in much the same manner as similar activities in the United States are unified under the National Tuberculosis Association.

Outstanding Developments During 1919

Great forward strides were made during 1919 in anti-tuberculosis work throughout all France. By the end of the year dispensary organization had been completed in twenty-one of the departments of the country, and educational campaigns against tuberculosis had been conducted throughout twenty-eight departments. Government officials as well as physicians and laity showed themselves alive to the urgency for action against the inroads of the disease, and co-operated heartily with the Commission in all its plans. The control program which was developed and put into operation in several newly organized units seems to meet the requirements admirably, and offers definite promise of supplying the need for a standardized working plan. During the year, also, the initial step was taken in the nationalization of the

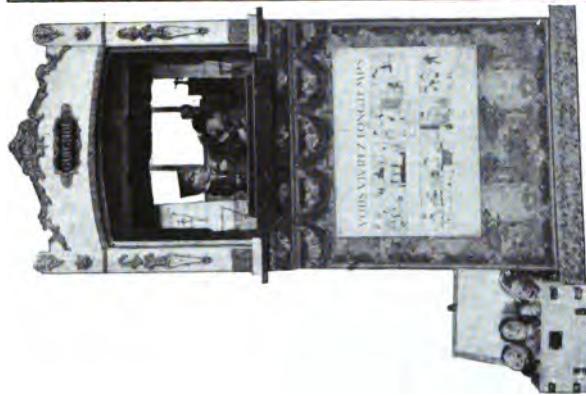
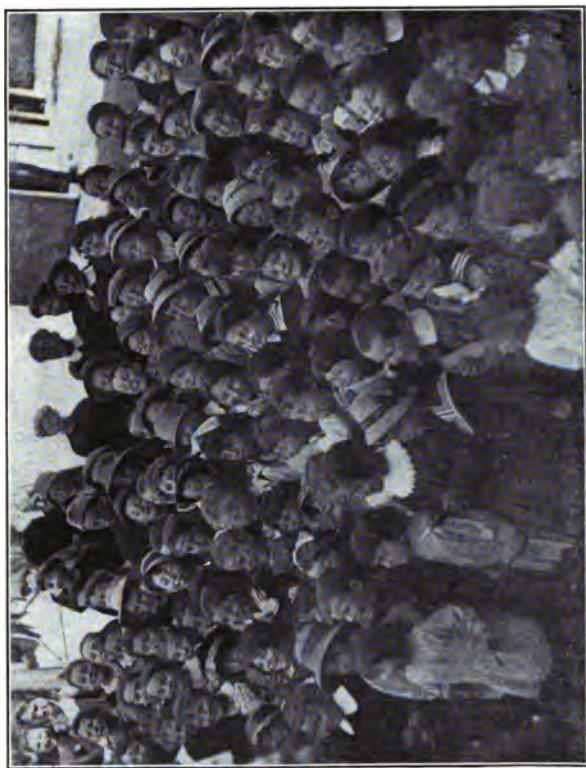


Fig. 12.—Eager admirers of the hygienic Punch-and-Judy. The exhibit appears at the left. An important educational feature of the campaign against tuberculosis in France



Fig. 13.—Effect of hookworm disease on growth. Queensland, Australia. Left, boy of eighteen years, hookworm free; right, boy of nineteen, heavily infected with hookworms

tuberculosis campaign. This was when the Comité National—an organization created in 1915 for the aid of discharged tuberculous soldiers—assumed the title of the National Committee of Defense Against Tuberculosis. The new agency will extend its field of activity until it embraces the entire tuberculosis problem of the country.

Financial Participation of Government in Control Program

Another outstanding feature of the 1919 work was the enactment by Parliament of a law which provides that within five years every department of France must either construct a tuberculosis sanatorium of its own, or arrange to have the sanatoria of other departments receive its patients. The Central Government has bound itself to assist in the construction and maintenance of the sanatoria to the extent of 50 per cent of the cost. Furthermore, French general and municipal councils, in the various departments in which the Commission organized new tuberculosis dispensaries during the year, appropriated approximately \$713,000 for anti-tuberculosis work. In the department of Eure-et-Loir, where the initial rural dispensary work was undertaken, an agreement was reached between the authorities and the Commission whereby the department will take over all the

administrative expenses of its dispensaries in 1920. The Commission will provide only the salaries and transportation expenses of its physicians and nurses. These co-operative measures are an indication of the earnestness with which national and local authorities are facing the problem of tuberculosis control.

Progress in Control of Hookworm Disease

Work for the relief and control of hookworm disease was continued during 1919 in the twelve states of the United States and in the sixteen foreign states and countries here mentioned:

Southern United States	West Indies
Alabama	British Guiana
Arkansas	St. Lucia
Georgia	Trinidad
Kentucky	
Louisiana	
Maryland	Costa Rica
Mississippi	Guatemala
North Carolina	Nicaragua
South Carolina	Panama
Tennessee	Salvador
Texas	
Virginia	
Central America	
The East	Brazil
Ceylon	Federal District
China	Rio de Janeiro
Seychelles	São Paulo
Siam	
Queensland (Australia)	

Eight new fields of hookworm operation were entered during the year. Infection surveys were completed or inaugurated in six of these

areas, and relief and control measures were begun in the two others. Surveys were undertaken and completed in the states of Minas Geraes and Paraná (Brazil); and other surveys were begun, but not completed by the end of the year, in the state of Maranhão (Brazil), in Porto Rico, and in Colombia, South America. An active campaign for the relief and control of hookworm disease was launched in Jamaica on May 1, and in West Virginia late in December. At the completion of the survey of Minas Geraes and Paraná in Brazil, these states entered upon a co-operative program of relief and control.

Invitations to Participate in Control Measures

An invitation to conduct an infection survey of the island of Santo Domingo, and to follow the survey, if deemed expedient, with measures of relief and control, was received from Admiral Snowden. This invitation had the approval of the Secretary of the Navy. Other invitations which reached the Board during the year, and which were accepted, were from the Health Officer and the Governor of Porto Rico, the invitation being forwarded through the Bureau of Insular Affairs, a branch of the War Department; and from the states of Bahia, Santa Catharina, and Espirito Santo (Brazil). The

initial step in each of these new fields will be an infection survey.

Outstanding Developments in Hookworm Control During 1919

During 1919 the outstanding features in the various fields of operation against hookworm disease were the rapid development in the installation of adequate latrine systems in advance of treatment campaigns, the increased financial participation of governments, and the evolution of anti-hookworm demonstrations into comprehensive public health agencies.

Failures of Previous Campaigns

The high re-infection rate in Ceylon brought out sharply the fact that unless soil pollution is stopped, treatment for hookworm disease brings only temporary relief. It is imperatively necessary not only that latrines be provided but that they be properly used. Porto Rico also affords a striking example of the hopelessness of treatment campaigns unless they are accompanied by good sanitation. More than \$347,000 has been spent in the hookworm relief measures which have been in progress in that island since 1902. A recent infection survey showed the infection to be as high as when the original program was begun. The indications are that more than 80 per cent of the rural popu-

lation remain infected. At more than three-fourths of the rural homes there were no latrines.

Value of Re-infection Surveys

Re-infection surveys were conducted during 1918 and 1919 in a number of previously treated areas in countries with which the Board has been in co-operation. The localities re-surveyed included, among others, areas in Ceylon, Costa Rica, Salvador, Nicaragua, British Guiana, St. Vincent, and Trinidad. All showed rates of re-infection corresponding inversely with the pro-

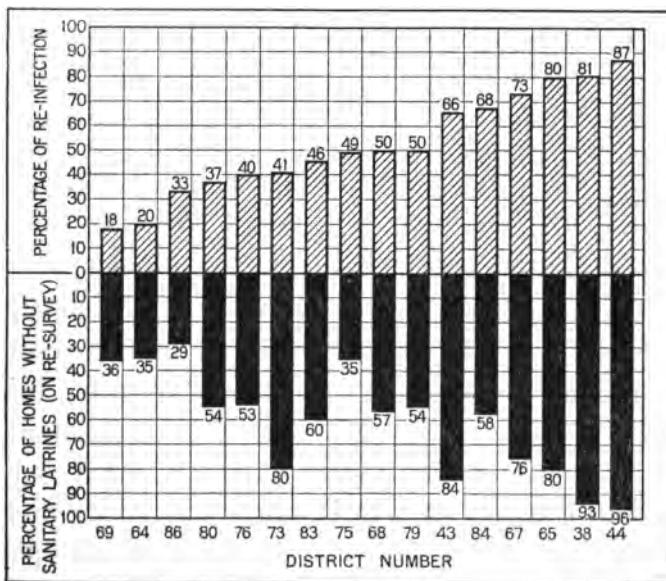


Fig. 14.—Relationship between (1) absence of sanitary latrines and (2) rates of hookworm re-infection. Sixteen districts in Trinidad

portion of rural homes provided with adequate and regularly used latrines. The results of the re-surveys were exhibited in graphic form and brought to the attention of the respective governments. At the same time the suggestion was made that, since it had proved futile to depend upon treatment alone as a permanent relief measure, work should be discontinued unless Government could sanitize all areas in advance of treatment, and keep them under a permanent system of sanitary supervision. The suggestion met with gratifying response. Many of the governments adopted the suggestion at once, others have done so more recently, and even among the most backward there are manifestations of a very earnest desire to inaugurate and carry to completion a program of advance sanitation.

Pre-campaign Sanitation in West Indies

Considered from the standpoint of permanent achievement, the results for 1919 in the West Indies surpass anything previously recorded for these colonies, because definite and permanent progress was made in sanitation. In every one of the colonies in which work was conducted during 1919, or in which it is planned to conduct work during 1920, Government is thoroughly sanitating each area of operation well in advance

of the inauguration of a treatment campaign. Latrines of a standard type, approved by the boards of health of the respective colonies, are being built, and permanent staffs of sanitary inspectors are being provided to enforce the sanitary regulations.

Advance Sanitation in Central America

In view of the fact that the Central American countries, with the possible exception of Costa Rica, have been slow in accomplishing definite results in sanitation, it is especially gratifying to report that they are now earnestly striving to secure proper sanitation of their areas at least six months in advance of treatment campaigns. The government of Panama has recently issued a decree making latrine construction obligatory throughout the republic, and the authorities in Salvador and Nicaragua have followed their earlier proclamations along this line, requiring the erection of latrines, with legislative provision for sanitary supervision to insure complete compliance with the laws.

Securing the Use of Latrines in Ceylon

The outstanding sanitary problem confronting the campaign workers in Ceylon remains that of securing the proper use of the latrines which have been erected on all the estates. The chief

difficulty lies in the fact that the Tamil coolies are strongly disinclined to use latrines, and often prove intractable. By insisting, in advance of the opening of treatment campaigns, that latrines shall be used and that the lines about laborers' quarters shall be maintained in sanitary condition, Government is placing on estate owners and superintendents the burden of securing proper compliance with its sanitary rules and regulations. There can be no doubt that this accomplishment marks a long stride forward. With proper support from the estate owners, it should not prove unduly difficult to accustom the mass of Ceylon laborers to the use of latrines, and to give them in addition at least a rudimentary education regarding other fundamental factors of sanitation.

Government Financial Participation in Hookworm Control

One index for gauging the measure of official and public recognition that is afforded the work, is the amount that governments grant toward its support. In this respect, too, the year 1919 showed steady progress. The governments of Guatemala, Nicaragua, Panama, and Salvador made their first appropriations toward the support of the program for hookworm control. In these countries the amount of the support

accorded was not large, but when their financial condition is recalled, and it is remembered that other pressing problems demand a large share of their resources, these pioneer appropriations assume added significance. Salvador and Nicaragua appropriated \$10,000 each for the year 1920, and the government of Panama, in its biennial budget for the period from July 1, 1919, to July 1, 1921, made an appropriation of \$5,000 yearly for the two-year period. Costa Rica, in spite of disturbed political conditions, is endeavoring to continue its co-operation, and has agreed to increase its budget for 1920 from \$6,400 to \$19,600. Guatemala, too, has made a beginning by appropriating the sum of \$1,200 toward the 1920 program.

Resumption of Work in Siam with Government Aid

The Siamese Government gave little financial support to the initial demonstration in hookworm control which was conducted in that country from February 7, 1917, to March 15, 1919. The work convinced the authorities of its value, however, and they requested its continuation. Therefore during 1919 a joint plan was adopted, providing for the extension of anti-hookworm measures and the undertaking of general public health activities throughout a wide rural area of the country. Operations

under the new program will be begun early in 1920.

Approximately \$17,000 yearly has been appropriated directly to the work by the Red Cross of Siam, which will be the local co-operating agency. In addition, this society will provide laboratory headquarters and free entrance of all medical supplies, and will secure the active

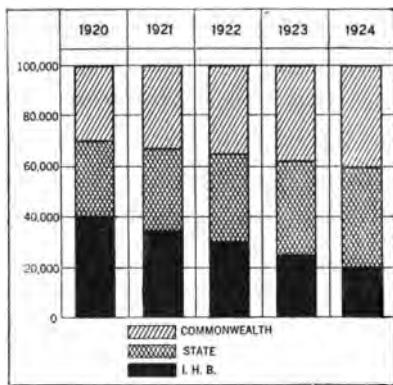


Fig. 15.—Sliding scale appropriations for health work in Australia. Five years beginning January, 1920

be used to pay the salaries of two directors and to buy drugs and scientific equipment.

Opening of Work in Queensland Under Enlarged Program

The inauguration of operations in Australia under the new plan, calling for greatly increased government and local support, was delayed until October 1, 1919. The delay was due to the necessity of securing and training a highly

support of all local government officials in the enforcement of sanitary regulations. As its share of the expense of the first year's work, the Board will be called upon to appropriate approximately \$10,480, to

qualified director to supervise the comprehensive health measures embraced within the proposed plan of procedure. The plans call for the annual expenditure, for five years, of \$100,000 from funds provided by the Federal and state governments and by the Board. The funds provided by the Board are to be contributed on a sliding scale for five years, at the end of which time the expense of the work will be borne entirely by Government (see Fig. 15, page 36).

Hookworm control measures are to form the central feature of the new plan, which is expected eventually to lead to the establishment of a modern, well-equipped Federal ministry of health. The initial steps will consist of hookworm control measures along the coast of Queensland, with surveys of the Northern Territory, Western Australia, and New South Wales. Later, control measures will be undertaken in the Australian South Pacific Islands, lately acquired from Germany, which include New Guinea and the Bismarck Archipelago.

Increased Government Support in Brazil

The graph and the maps, Figs. 16 and 17, exhibit the increase in territory covered and in local financial support received during the three years that have elapsed since the first infection survey and control demonstration were under-

taken in Brazil. The movement for increased local financial support, which began in 1917, continued and showed gratifying growth during 1919. The Federal Government made one appropriation of

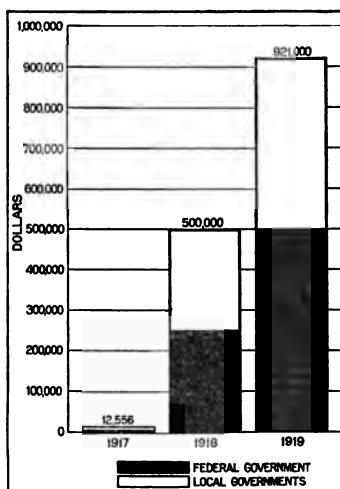


Fig. 16.—Increase in government and local support for anti-hookworm measures in Brazil. Comparison of funds appropriated for 1917, 1918, and 1919

\$500,000 for the partial support of campaigns which the states might institute for the control of rural endemic diseases, and another of \$500,000 toward the eradication of yellow fever from the country. In the course of the year, Federal and state governments together provided about \$921,000 for operations in rural sanitation, in which measures

against hookworm disease are to play a leading part. In all, ten states (including the Federal District) joined in a systematic attack on hookworm disease. Thirty-two posts were maintained in these states entirely at government expense.

Public Health Training in Brazil

The Laboratory of Hygiene which was established in connection with the Faculty of Medicine

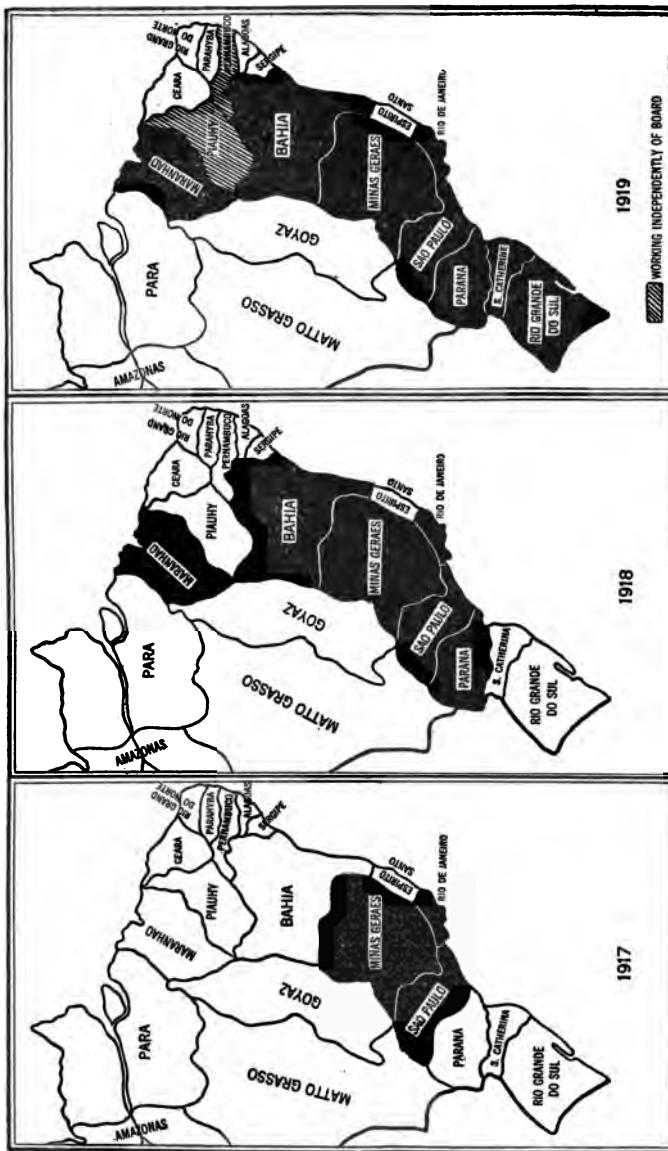


Fig. 17.—Growth of interest in anti-hookworm work in Brazil, 1917-1919

and Surgery of the University of São Paulo, has been in operation since March, 1918. It offers a general course in various branches of hygiene and public health administration. Dr. Samuel T. Darling and Dr. Wilson G. Smillie, respectively, are the director and the assistant director of the new department. The work of the 1919 school year began in June. The course now being offered includes (in addition to classroom lectures) laboratory work in malaria and hookworm disease, disinfection, fumigation, and water and milk analysis; a study of various types of public health literature and publicity material; and practical field work giving opportunity for participation in anti-mosquito campaigns, in factory and sanitary inspections, in demographical surveys, and in operations for malaria and hookworm control. The staff of the school has also spent much time on practical field studies in the control of hookworm disease. It is expected that a part of the results of their researches will be published in current medical periodicals.

Organization of Department of School Hygiene

A division of school hygiene has lately been organized in connection with the department. The work of this division is to be conducted along the lines which are being followed with

success in the United States and in England. A Brazilian physician and a Brazilian nurse have been placed in charge of the work, and a school of about eight hundred pupils has been assigned as the initial field of demonstration. The new undertaking is believed to represent the first attempt that has been made in South America to utilize the school nurse to bring about that co-operation between parents, physicians, and teachers which is so essential for the utmost welfare of school children.

Fellowships as a Means of Promoting World-Wide Hygienic Progress

Perhaps no field of health work offers greater promise of definite and permanent usefulness than that of public health training. The goal of developing permanent and effective public health agencies in various countries lies in the direction of training competent native men to administer the public health programs. With the award of fellowships for graduate study, particularly to carefully selected medical men who reside in the countries where work is carried on, there is excellent prospect that men well trained in the more essential requirements of public health administration may return to their countries and achieve leadership in public health affairs.

Public Health Fellowships During 1919

Provision has been made for twenty-eight fellowships for study in the various branches of public health, and for seven to prepare teachers of hygiene and public health. It is hoped that the teachers will be available for possible service in schools of hygiene and public health in their native lands, as well as for chairs of public health in undergraduate medical schools. By the close of 1919 sixteen of the fellowships had been bestowed. Seven were granted to Brazilian and four to Czechoslovakian physicians; the remaining five went to medical graduates from Ceylon, Salvador, and the United States. In addition, provision has been made for bringing ten young French physicians to the United States for special study in preparation for service with the Board's Commission for the Prevention of Tuberculosis in France. No actual appointments under the latter grant, however, had been made up to the beginning of 1920.

Study Leave for Staff Members

Progress has also been made toward carrying out the plan whereby special health courses at leading American or foreign institutions may be pursued by members of the administrative or field staff. Up to the end of 1919 five regular

staff members had availed, or were availing, themselves of this study privilege: four at the School of Hygiene and Public Health at Baltimore, and the fifth at the London School of Tropical Medicine. Six other physicians, all of them under appointment to the field staff, were pursuing an intensive course of training at the Baltimore school. This preliminary training includes brief courses in medical entomology, parasitology, and protozoölogy, which it is hoped will enable them to discharge the more promptly and acceptably the duties involved in field positions. After it becomes possible to choose new staff members among graduates of public health schools, elementary training of this kind will be unnecessary.

Organization of Public Health Laboratory Service

A public health laboratory, like a department of vital statistics, is essential to any effective system of public health administration. If a health service is to act intelligently, facilities must be at hand for making prompt and accurate diagnoses. These involve the examination of specimens of blood, feces, and urine; the analysis of water, food, and milk supplies; and many other bacteriological, chemical, or sanitary operations. The numerous requests which have been received for counsel in organizing or

improving the laboratory service of various national, state, and municipal health departments led to the engagement of Col. Frederick F. Russell, of the United States Army Medical Service, to undertake the organization of a division of laboratory service under the auspices of the Board. His first duty was to assist the Alabama State Board of Health in re-organizing and further developing its laboratory facilities.

Study of Laboratory Needs in Utica

It has been suggested at various times that efficiency and economy might perhaps be promoted in some communities by having a central laboratory which could furnish the diagnostic work required by the health service, as well as meet the needs of the government and private hospitals. Pooling of the resources should make it possible to employ a more highly skilled staff, permit research work, and at the same time reduce the unit cost. In September, 1919, Dr. J. H. Waite, a member of the Board's staff, made an inquiry into the possibilities in this respect at Utica, New York. Reports and recommendations based on the findings have been submitted, and are now being considered by the New York State Board of Health. The survey of Dr. Waite was largely provisional, and marked an attempt to learn whether similar

studies offered promise of useful development in this direction.

The Board as a Clearing-House for Public Health Information

During the year 1919 the first steps were taken looking toward a comprehensive study of public health administration. Preliminary studies were made, dealing with the public health work done by the Children's Bureau, by the Bureau of the Census, and by the Bureau of Education, of the Federal Government; a general study of public health administration in Massachusetts was undertaken with the assistance of the State Department of Health; a collection was made of the public health bills which have been presented to Congress, and of the reports of committee hearings and legislative debates on these bills; information on the organization of state, county, city, and town health administration, and on the relationship between state and local health authorities, was gathered from the laws and regulations of the various states; data on expenditures for public health purposes by states, cities, and countries were brought together; a special report on hospitals and dispensaries was prepared and published; and a report on infant welfare work in New York City was revised. As a background for the study of public health

administration, a current working bibliography for office use was compiled.

Study of Facilities for Medical and Public Health Training

Dr. R. M. Pearce, director of the Division of Medical Education of the Rockefeller Foundation, visited Chile and Paraguay and made a study of medical education. His investigations were undertaken as part of the plans calling for an intensive study of the status of medical and public health training in countries throughout the world. The Board's Department of Surveys and Exhibits compiled memoranda containing information of interest in the field of public health, and distributed them gratuitously to educational institutions, government authorities, commercial bodies, and private institutions. The same department also continued the survey that it had begun in 1918 for the purpose of bringing together information on the educational facilities employed by various countries in the teaching of hygiene and public health. Reports dealing with the subject were prepared for England, France, Holland, Switzerland, Italy, Spain, and Germany.

Issuance of Handbook on Methods for Hookworm Control

A special handbook outlining in detail the field methods employed by the Board in the control

of hookworm disease, was published during the year. The booklet was written by Dr. H. H. Howard, Regional Director for the West Indies, and was entitled: "The Control of Hookworm Disease by the Intensive Method." The treatise contains data of practical value to physicians, nurses, and laboratory personnel. It should also prove useful as a means of interesting governments and of stimulating them to undertake anti-hookworm operations, either independently or in conjunction with the Board.

Publications

The following is a complete list of the reports and publications issued by the International Health Board during the year 1919.

PRINTED REPORTS (*for general distribution*)

Annual Report for the Year 1918.

Control of Hookworm Disease by the Intensive Method. By Dr. H. H. Howard, Director for the West Indies.

LITHOGRAPHED REPORTS (*for limited distribution*)

Annual Reports for 1918 on Work for the Relief and Control of Hookworm Disease in the following countries:

West Indies

British Guiana	Dr. F. W. Dershimer
St. Lucia	Dr. Stanley Branch
St. Vincent	Dr. P. B. Gardner
Trinidad	Dr. G. C. Payne

Central America

Costa Rica	Dr. Louis Schapiro
Nicaragua	Dr. D. M. Molloy
Panama	Dr. W. T. Burres
Salvador	Dr. C. A. Bailey

South America

Brazil

Dr. L. W. Hackett

The East

Fiji

Dr. G. P. Paul

Queensland

Dr. J. H. Waite

Seychelles

Dr. J. F. Kendrick

Siam

Dr. M. E. Barnes

Reports on Hookworm Infection Surveys in the following countries:

State of Sao Paulo, Brazil Dr. J. L. Hydrick
Jamaica Dr. M. E. Connor

The Illustrated Story of Hookworm Disease.

Report on Microscopic Re-examination of Patients Cured Prior to June 1, 1918, in Work for the Relief and Control of Hookworm Disease in Trinidad—Dr. Geo. C. Payne.

Report on Work for the Relief and Control of Soil-Pollution Diseases in Texas from April 15, 1916, to December 31, 1918—Dr. P. W. Covington.

Report on Rural Sanitary Work in Seven Mississippi Counties from October 20, 1916, to July 1, 1919—Dr. W. S. Leathers and Dr. Chaillot Cross.

Report on Rural Sanitary Work in Harrison County, Mississippi, from January 18 to December 31, 1918—Dr. P. G. Pope.

Articles and Reprints

Other important contributions to medical and public health literature were made during the year. Most of these were in the form of articles published in medical journals that are widely circulated among persons interested in medical and public health topics. A list of these articles follows:

DR. M. E. BARNES. Report for the third quarter, July-September, 1918, on work for the eradication and control of uncinariasis in Siam. *China Medical Journal*, Jan., 1919, v. 33, p. 74-75.

DR. C. C. BASS. Studies in malaria control:

No. 1. Relative frequency of malaria in different ages and age groups in a large area of great prevalence. *Southern Medical Journal*, Aug., 1919, v. 12, p. 456-460.

No. 2. Treatment of malaria with the special object of disinfecting infected persons. *Journal of the American Medical Association*, Apr. 26, 1919, v. 72, p. 1218-1219.

No. 3. Observations on the prevalence of malaria and its control by treating malaria carriers in a locality of great prevalence in the Mississippi delta. *Southern Medical Journal*, Apr., 1919, v. 12, p. 190-193.

No. 4. Frequency of malaria relapse in an area of great prevalence in the Mississippi delta. *Contributions to Medical and Biological Research*, dedicated to Sir William Osler, etc., 1919, p. 323-326.

No. 5. Importance of disinfecting all cases treated as a factor in malaria control in a locality of great prevalence. *Southern Medical Journal*, June, 1919, v. 12, p. 306-310.

No. 6. Frequency of malaria infection without recognized symptoms compared with recognized attacks in an area of great prevalence. *Southern Medical Journal*, Aug., 1919, v. 12, p. 460-462.

No. 7. Proportionate dose of quinine required to obtain same results in treating malaria in children of different ages as in adults. *Southern Medical Journal*, Aug., 1919, v. 12, p. 462-465.

No. 8. Some observations indicating that effective immunity against malaria parasite infection does not occur. *Southern Medical Journal*, Aug., 1919, v. 12, p. 465-467.

No. 9. Effective and practical treatment of malaria to disinfect infected persons and to prevent relapse. *Journal of the American Medical Association*, July 5, 1919, v. 73, p. 21-23.

Some phases of tropical medicine in the recent world conflict. *New Orleans Medical and Surgical Journal*, Aug., 1919, v. 72, p. 72-81.

DR. M. E. CONNOR. Questionario sobre fiebre amarillo. Guayaquil, Imp. municipal, 1919, 10 p.

Conferencia celebrada ante el profesorado de las escuelas de la ciudad de Guayaquil, Guayaquil, 1918, 5 p.

DR. S. T. DARLING. Pesquisas recentes sobre a opilação na Indonésia. *Annaes paulistas de medicina e cirurgia*, Feb., 1919, v. 7, p. 25-38. Same reprinted in *Faculdade de medicina e cirurgia de São Paulo, Instituto de higiene, Boletim* N. 2.

Sobre algumas medidas anti-malaricas em Malaya. *Faculdade de medicina e cirurgia de São Paulo, Instituto de higiene, Boletim* N. 1.

DR. F. W. DERSHIMER. The uncinariasis campaign. *British Guiana Medical Annual*, 1919, v. 22, p. 29-32.

DR. LIVINGSTON FARRAND. Future co-operation between the American Red Cross and public health agencies. *American Journal of Public Health*, Aug., 1919, v. 9, p. 583-585.

DR. S. M. GUNN. Une guerre nécessaire contre la tuberculose. *Je sais tout*, May 15, 1919, v. 15, p. 529-537. Same reprinted. English trans. in *American Journal of Public Health*, Oct., 1919, v. 9, p. 767-775.

DR. V. G. HEISER. Teaching public health by demonstration, New York State department of health. *Health News*, Sept. 1919, v. 14, p. 226-229. Same reprinted.

DR. A. I. KENDALL. National and international relations of sanitation in Ecuador. *Journal of the American Medical Association*, Feb., 22, 1919, v. 72, p. 599-600.

DR. MARIO LEBREDO. Consideraciones que sugiere lo publicado por el Dr. Noguchi sobre etiología de la fiebre amarilla. *Vida Nueva*, July, 1919, v. 11, p. 145-155.

DR. E. C. MEYER. Hospital service in rural communities. *Journal of the American Medical Association*, April 19, 26, May 3, 10, 17, 1919, v. 72, p. 1135-1136, 1219-1223, 1365-1367, 1460-1463. Same reprinted.

DR. J. A. MILLER. Tuberculosis among European nations at war. *American Review of Tuberculosis*, Aug., 1919, v. 3, p. 337-358.

DR. WICKLIFFE ROSE. Field experiments in malaria control. *Journal of the American Medical Association*, 1919, v. 73, p. 1414-1420 (abbreviated article, maps omitted). Same reprinted, with maps, 28 p. Spanish trans. in *Journal of the American Medical Association* (Spanish edition), Nov. 15, 1919, v. 2, p. 660-667. Same reprinted.

DR. LOUIS SCHAPIRO. Physical and economic benefits of treatment for hookworm disease. *Journal of the American Medical Association*, Nov. 15, 1919, v. 73, p. 1507-1509. Same reprinted. Spanish trans. in *Journal of the American Medical Association* (Spanish edition), Dec. 15, 1919, v. 2, p. 793-795.

DR. H. A. TAYLOR. Malaria control demonstration at Hamburg, Arkansas. *Southern Medical Journal*, Feb., 1919, v. 12, p. 74-86. Same reprinted.

DR. J. H. WAITE and DR. I. L. NEILSON. Study of the effects of hookworm infection upon the mental development of North Queensland school children. *Medical Journal of Australia*, Jan. 4, 1919, v. 1, p. 1-10. Same (without tables) in *Journal of the American Medical Association*, Dec. 20, 1919, v. 73, p. 1877-1879. Same reprinted.

DR. LINSLY R. WILLIAMS. Public health work in Germany in the area occupied by the American army, New York state department of health. *Health News*, Oct., 1919, v. 14, p. 249-252.

In addition, Dr. Noguchi, a member of the staff of the Rockefeller Institute for Medical Research, whose services had been lent to the International Health Board for special studies, contributed papers to the *Journal of the American Medical Association* and to the *Journal of Experimental Medicine*. The articles set forth the chief features and the results of his investigations at Guayaquil, Ecuador, regarding the etiology of yellow fever.

Other Publications and Exhibits

An exhaustive bibliography on hookworm disease, intended to cover all available references in medical literature on this subject, is now nearing completion and will be ready for publica-

tion at an early date. Further progress has been made, also, on the production of a film on hook-worm disease and in connection with a lecture chart on malaria.

Lending Staff Members for Special Service

The Board is frequently called upon to lend its staff members to health agencies for special assignments of research and investigation, or to advise health officers on definite aspects of their work. Special service of this kind constitutes one of the fields in which the Board may be helpful, and in which it may do much to realize its fundamental aim: that of aiding in organizing or further developing health services of various kinds.

Survey of Health Conditions at Halifax

The survey of health conditions at Halifax, which was undertaken by Dr. Heiser soon after the holocaust there, is a case in point. The study led to definite recommendations for the creation of a modern municipal health organization. The recommendations were accepted and were embodied in the new health program adopted for the city. The Board was invited to keep in close touch with the plans, and its co-operation and advice at every step of the way have been welcomed.

Publication of Railway Sanitary Code for United States

The Board donated, also, the services of one of its staff members to assist in the preparation of a railway sanitary code for the United States Railroad Administration. This effort marks the first attempt to compile a uniform code of such a nature for the railroads of the country. It promises to have a far-reaching and salutary effect as a means of giving a practical education in hygiene to the 2,000,000 railroad employes and to the many millions of railroad patrons.

Other Incidental Activities of Staff Members

Dr. Waite made a survey of health conditions in Olean, N. Y., and furnished a report to the New York State Department of Health. Among other activities for which staff members were lent during the year were the completion of the special social hygiene survey which was undertaken in 1918 for the American Society of Social Hygiene, and the supplying of staff members to conduct a nursing survey for the American Red Cross. These and the many other less important and incidental services of this kind which were rendered during the course of the year, represent in their aggregate an important contribution toward the promotion of "the well-being of mankind throughout the world."

Additional Information in the Appendix

The annual report of the International Health Board for the year 1918 contained, in the form of an appendix, a detailed account of the problems encountered by the Board throughout the course of its various field operations for the control of hookworm disease, and a discussion of the working methods employed in meeting these problems. Health workers throughout the world seemed to find this text of value as a working handbook. Requests for copies of the report exceeded the available supply. In order that the numerous demands for this material might be met, the Board has included in its report for the current year a reprint of the hookworm section of the report for 1918, revised to include the results of the research and the practical work of 1919. In the following pages therefore will be found a complete discussion of the Board's experience up to the end of 1919 in measures for the control of hookworm disease.

The sections of the appendix relating to the control of yellow fever, the studies and demonstrations in malaria control, and the campaign against tuberculosis in France deal primarily with the results for the year 1919.

APPENDIX

I

EXTENT AND SEVERITY OF HOOKWORM DISEASE

Hookworm infection is found in all tropical and sub-tropical countries in the zone which encircles the earth between parallels 36° north and 30° south. An idea of the wide-spread prevalence of the disease within this infected zone may be gained from the following statements. In fifteen foreign countries, measures for the relief and control of hookworm disease were terminated during 1919 in eighty-three rural areas having an average population of 4,322. In fifty-eight of these areas more than sixty of every one hundred persons examined were found to be infected. In fourteen of the areas the infection rate was between 90 and 100 per cent; in sixteen between 80 and 90 per cent; in fifteen between 70 and 80 per cent; and in twelve between 60 and 70 per cent. In only three areas were rates lower than 20 per cent recorded.

High Rate of Infection in India. Microscopic examination in Ceylon of more than 50,000 Tamil coolies from Southern India has shown more than 98 per cent of them to be infected. This confirms the investigations carried out by the Indian Medical Service at Negapatam, the great clearing port for labor leaving South India, which showed 99.8 per cent of the emigrant laborers to be infected. Much of India's population of 300,000,000 is under the burden of a heavy hookworm infection and is the source from which the disease is carried to many parts of the world. In some of the rural regions of that country, from 80 to 100 per cent of the population is infected.

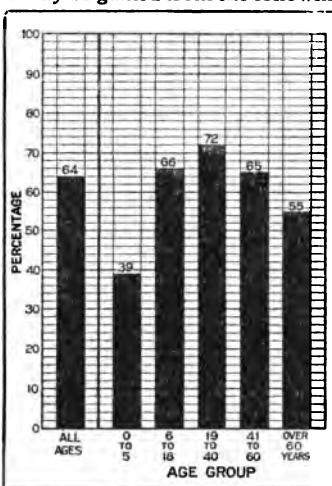


Fig. 18.—Rates of hookworm infection by age—all countries. Based on examinations from March 12, 1914, to December 31, 1919

The original investigation carried out by Lieut.-Col. Clayton Lane under the auspices of the Indian Research Fund Association, in a group of tea gardens in Assam, showed 63 per cent of the 33,590 persons examined to be infected; and a second inquiry carried out by the same investigator, in the jails of Bengal presidency, demonstrated the infection in 8,973, or 71.3 per cent, of the 12,570 prisoners examined. In all, twenty-six jails were visited, and the rates of infection recorded ranged from 47.9 in the Presidency jail at Calcutta to as high as 86 per cent in the jail at Hooghly. The sanitary authorities believe that more than 30,000,000 of the 45,000,000 inhabitants of Bengal proper are infected, and are undertaking a systematic attack on the disease, beginning with a campaign in the schools.

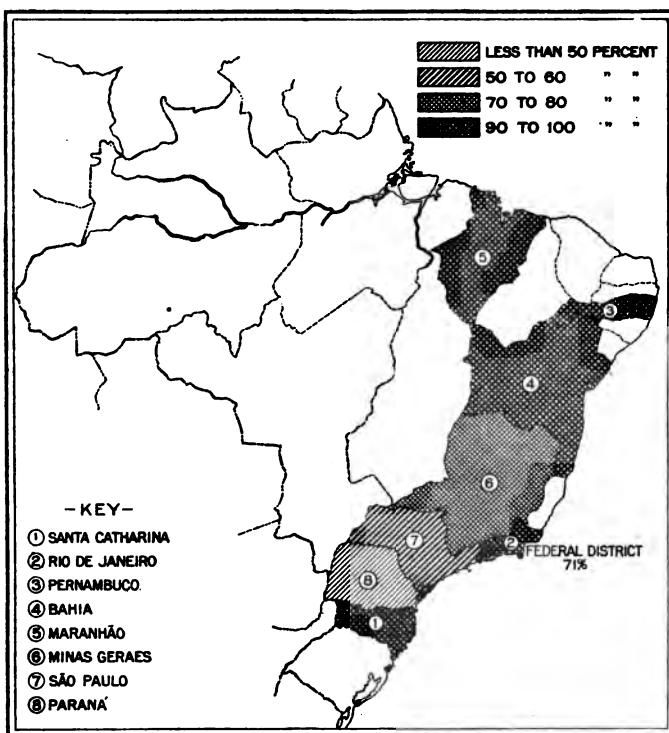


Fig. 19.—Rates of hookworm infection in Brazil, by states. Based on surveys and control measures up to December 31, 1919

Prevalence of the Disease in Brazil. In Brazil the field of operations against hookworm disease is almost unlimited. As far south as the state of Rio de Janeiro the average infection has reached 85 per cent, and the recent survey of the state of Maranhão shows that in no town yet examined in that state is the incidence of the infection less than 96 per cent. Considering all the areas of Brazil in which anti-hookworm work was completed during 1919, not less than 86.8 per cent of all persons examined were found to be infected with one or more kinds of intestinal parasites, hookworm infection alone being present in two of every three persons examined.

The Director of Rural Sanitation estimates that more than 80 per cent of the adults and more than 90 per cent of the children living in rural portions of the Federal District of Brazil are infected with some form of intestinal parasite. The number infected with hookworm he puts at 100,000, or two-thirds of the district's rural population. Among the first 1,839 persons examined in Jacarepagua, a typical rural community of this District, the percentage found infected with hookworm was 75, and only six persons were found who were free of all forms of intestinal parasites.

In the survey of the state of São Paulo three of every five persons examined were found to be infected with hookworm disease and four of every five with some type of parasite. On coffee plantations in the latter state practically 100 per cent of the adult population, or persons fourteen years of age or over, are infected, and the average number of hookworms harbored per person is as high as 160. Among the first 450 persons examined in the state of Paraná every one was found to be infected with hookworm. The infection on the plateau of this state, except in one or two cities, is low, but its littoral, though well within the temperate zone, shows an incidence of infection among the highest in Brazil. Similarly, the preliminary observations in the recently inaugurated survey of the state of Santa Catharina show a very high incidence of infection along the coast, ranging in seven towns from 77 to 98 per cent.

Infection Rates in Sumatra and Formosa. In Sumatra the infection is found probably as frequently as anywhere else on the globe. Van der Heyden and Schueffner examined, during 1914,

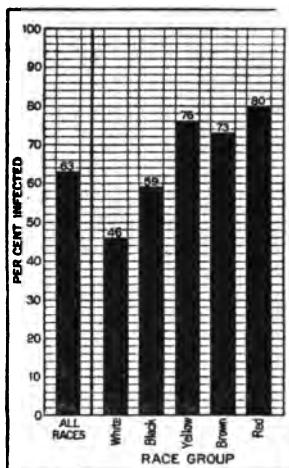


Fig. 20.—Rates of hookworm infection by race—all countries. Based on examinations from March 12, 1914, to December 31, 1919

thousands of laborers in the Lampung district of South Sumatra and reported that not a single one was without hookworm infection.

In Formosa, recently, among a group of political prisoners in the Taikoku jail, practically all of whom had come from the mountain villages of that country, 90.3 per cent infection was found among the first 300 prisoners examined. This led to the examination of 1,000 other prisoners, 97 of whom were Japanese and the other 903 Formosans. The inquiry developed that 59.0 per cent of the Formosans and 36.1 per cent of the Japanese were harboring hookworms.

Prevalence of Hookworm Infection in Central America. In Central America the results of approximately five years' work have shown that on the average two of every three rural inhabitants are infected. Within the borders of most of the countries, however, there are wide regional or climatic differences in the rates of infection, as in Guatemala, for example, where the infection rate on the Atlantic slope is only 37 per cent, as compared with 88 per cent on the Pacific. Operations in this country during 1919 were confined almost entirely to regions near the Pacific, and on the average eighty-six of every one hundred persons examined were found to be infected.

In Colombia, which adjoins the Central American countries on the south, there is an average infection rate of 78.1 per cent, ranging by provinces from the lowest (9.6) in Bogotá to the highest (98.7) in Ubate. For all districts having an altitude of less than 6,600 feet, the average infection rate is not less than 81.4 per cent. There are numbers of smaller areas in Central America where the infection approaches 100 per cent, as, to choose but one or two examples from the 1919 control operations, the district of Santiago, province of Veraguas, Panama, where 97 per cent of the people examined were found infected; and the districts of General and Osa in Costa Rica, where 94.9 per cent were found to be infected with hookworm and 100 per cent with one or another type of intestinal parasite.

Infection Rates in Countries Recently Inaugurating Control Measures. An infection rate of 60.5 per cent was recorded among 12,504 surface and underground workers examined in a control campaign carried out at the Pinghsiang colliery in China; of 33.4 per cent among 777 persons examined at the Tayeh Mines and Works in the same country; of 78 per cent among 37,971 persons examined in the province of Chiengmai, Siam; of 21.1 per cent among 21,844 persons examined in twelve small settlements in the state of Queensland, Australia; and of 52.3 per cent among 6,413 persons examined in the first two areas worked in the island of Jamaica. These are countries in which co-operative control measures have been inaugurated during the past three years. Reports from Australia had indicated that there was little or no infection among the aborigines, but over 80 per cent of all those examined to date have

been found infected. Arrangements for their treatment are now being made through the Chief Protector of Aborigines.

Factors Favoring or Retarding Infection. The influence of vegetation, shade, and the character and cultivation of the soil was strikingly shown in the state of Minas Geraes, Brazil, during 1919. This state is divided into two great regions: prairie and woods; the one is grassy and rolling, with little or no shade and with sandy soil; the other is fertile, with a clay subsoil and abundant lime matter. In the first region cattle are raised; the second was formerly a forest. In the sandy region only sixty-six of every one hundred persons examined were found to harbor hookworm disease; in the wooded

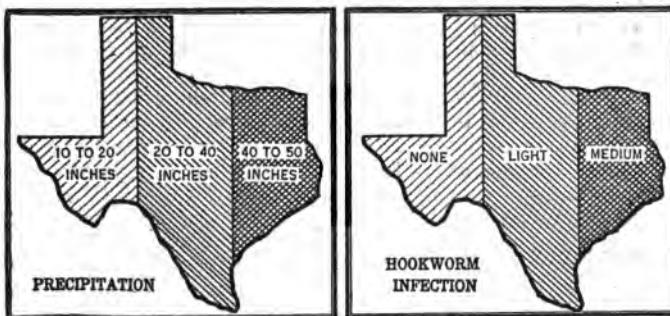


Fig. 21.—Correlation between rates of hookworm infection and amount of rainfall. Texas

region, there were ninety persons infected of every hundred examined. The town of Guinda, with 24.2 per cent, showed the lowest percentage of hookworm infection: it was situated in the midst of a region which possessed a dry and sandy soil, without vegetation, without shade, and with no cultivation.

Effect of Rainfall in Promoting, and of Salt in Retarding, Development of Larvae. Rainfall is an important contributing factor in the spread of the disease. In six adjoining settlements of Queensland, Australia, in which work was conducted during 1918, the percentage of hookworm infection ran parallel with the amount of rainfall. Thus, in two districts having an annual rainfall of less than 90 inches, the percentage of infection was 13.8, while that in four districts having more than 90 inches of rainfall was 27.8. Salt, on the other hand, plays an important part in retarding development of the larvae and in preventing the spread of the infection. In regions near the coast, upon which the sea frequently encroaches and the soil is impregnated with salt, the infection is always light. In Jamaica

during 1919, for example, the infection in a single district of twenty-eight square miles varied widely from the rates of 70 to 80 per cent recorded among East Indian laborers living in estate barracks, to those of 20 to 25 per cent established by examining the residents of low-lying and swampy sea-coast villages, where the sanitary conditions were no better than in the higher regions.

Infection in Relation to Altitude and Climate. The most favorable temperature for the development of the larvae is from 25° to 35° Centigrade (77° – 95° F.). Below 22° Centigrade (72° F.) few larvae develop. In the republic of Colombia, for instance—a country where sharp distinctions in climate follow the sharply differentiated zones of altitude—a survey just completed showed that in the zones of altitude where the climate was tropical or sub-tropical the average infection rate was 84.1 per cent, as compared with only 9.6 per cent in the temperate zone. In the cold regions there was no infection whatever.

In the state of Paraná, Brazil, there is heavy infection among the people of the coast towns, with very light infection on the plateau; and in Australia, similarly, a surveying trip to Chartres Towers, a famous gold mining center located at an altitude of 1,000 feet, disclosed a rate of only 3.0 per cent among the 1,817 children and 123 adults examined, as compared with a rate of 18 per cent among adults

and children living in the coastal plain of the same state. The history of the infected persons showed that more than three-fifths of them were native to the coastal area or had passed several vacations there. In Ceylon, too, as the staff workers move toward the higher central watershed, the rate of infection becomes lower and lower and clinical evidence of the disease almost disappears.

Hookworm Primarily a Rural Disease. Persons who live in the country, away from sewerage, and who work in the soil, are much more frequently infected with the disease than city residents. The urban districts of Porto Rico, for example, showed, in a recent survey, a rate of only 21 per cent infection, despite the fact that for the island as a whole the average

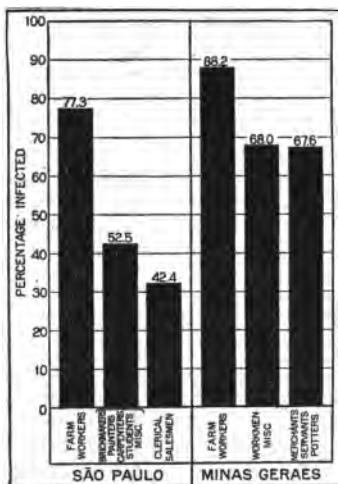


Fig. 22.—Rates of hookworm infection by occupation. States of São Paulo and Minas Geraes, Brazil



Fig. 23.—Family of sixteen, each member infected with hookworm disease.
Marion county, Mississippi



Fig. 24.—Group of Australian aborigines assembled for hookworm treatment. These indigenous people had been thought to be practically free of infection but examinations to date disclose an infection rate of 81 per cent

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rate is 82.6 per cent. In sugar and tobacco producing districts the infection rate was 85.5 per cent; and in coffee raising districts, where denser shade exists and conditions are more favorable for the development of larvae, it was 97.7 per cent.

Infection Rates by Occupations, in Colombia and Brazil. Figure 22, page 60, compares the rates of infection found among various types of workers in the states of São Paulo and Minas Geraes, Brazil. It indicates the contrast that exists between workers who are thrown much in contact with the soil and those whose work is either indoors or in urban districts. This distinction is further borne out by survey findings for the state of Matto Grosso, Brazil, where hookworm infection certainly exists and is wide-spread, though the nomadic horseback life of the cattle rangers who comprise the bulk of the state's population has prevented the disease from assuming serious importance economically or clinically.

The data collected with respect to occupations in Colombia coincide with those for other countries. As usual, the agricultural industries as a whole (including cattle raising, and the growing of coffee, sugar, and vegetables) gave the highest rate of infection, with coffee laborers showing the greatest prevalence (93.9 per cent) of any of the agricultural groups examined. The miners of Colombia, on the other hand, showed only 17.1 per cent infection—a surprisingly low rate of infection for miners—though the latter rate may doubtless be accounted for in part by the fact that the mines are located in temperate regions.

Relationship Between the Wearing of Shoes and the Rate of Infection. Persons who go barefooted, or those who in other ways allow the bare skin to come into contact with polluted soil, show correspondingly higher rates of infection than those who wear shoes. For example, the survey of the state of São Paulo, Brazil, concluded during 1918, showed only 41.2 per cent infection among shoe wearers, as compared with a rate of 62.9 per cent among persons who went barefooted. In Colombia, too, the infection survey showed an incidence of only 38.8 per cent among those who habitually wore shoes, as compared with 81.5 per cent among those who went barefooted. Everywhere the findings speak volumes in favor of the use of shoes, but in most regions the economic conditions preclude their widespread adoption.

SEVERITY OF THE INFECTION

The severity of the disease is now believed by many authors to depend primarily upon the number of worms harbored by infected individuals. Generally, the higher the percentage of persons infected in a given locality, the larger is the average number of worms harbored by infected individuals, the more severe are the symptoms found, and the more difficult is the disease to bring under control.

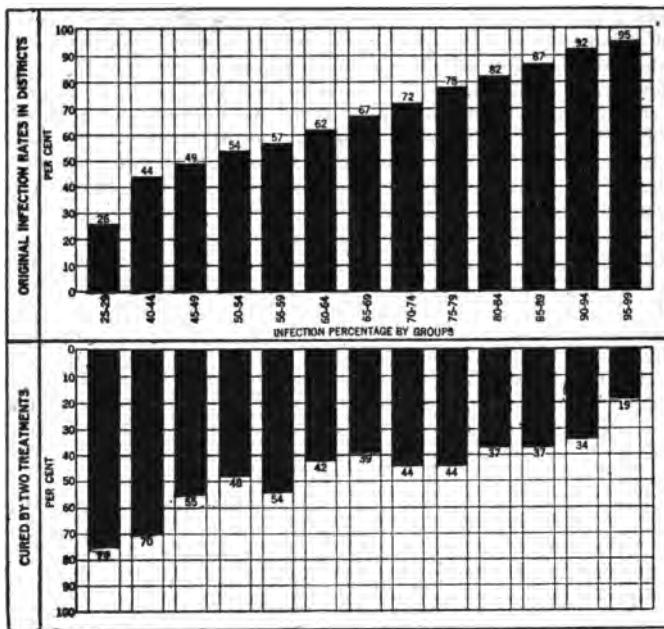


Fig. 25.—Difficulty of curing hookworm disease where infection rate is high. Relationship between rates of hookworm infection and cures by two treatments. One hundred fifty districts in Trinidad. Persons examined, 42,284

The difficulty of effecting cures in localities with high rates of infection is strikingly illustrated by figures compiled in Brazil and in Trinidad. In the former country, the percentage of persons cured by two treatments of the same drug, administered in the same manner, and under practically the same conditions, was 38 in Rio Bonito, a municipality having an infection rate of 88.5 per cent, and 71 in Guarulhos, where the infection was 57 per cent.

The statistics for Trinidad (Fig. 25) cover the examination of 42,284 residents of that colony during the period from May 15, 1915, to December 31, 1918. It will be noted that in districts with 25 to 29 per cent of their inhabitants infected, the percentage of infected persons cured by two treatments was as high as 75. As the rate of infection rose, the difficulty of curing increased, until in localities with extremely high rates of infection—representing between 95 and 99 per cent of their inhabitants—only 19 per cent of the infected persons could be cured by two treatments. The drugs

used and the conditions of administration were practically the same in all districts.

Determining Severity by Counting the Worms. The number of worms harbored by a group of individuals may be ascertained quite accurately by giving the persons a vermifuge and counting the worms expelled after the drug has acted. It is usual to count the worms for a period of two or three days following each treatment. Worm counts are of value not only because they reveal the average degree of infection in different communities, as well as the type of worm harbored, but also because they are of much assistance as a means of demonstrating the presence of the disease and enlisting popular support in measures for its control.

Infection Index in Different Regions. In Siam the feces of fifty-nine persons were examined for seven hours after first treatment. The average number of worms expelled was forty-five. More than half (thirty-nine) of the cases harbored less than twenty worms each. In Formosa, on the other hand, 11,663 worms were obtained from ninety-three persons who were given trial treatment. This is an average of 125 per person. The greatest number of worms obtained post-mortem was 1,139. In Nicaragua as many as 4,000 worms were recovered from a single patient, and in Brazil particularly high worm counts have been obtained in the states of São Paulo and Rio de Janeiro. In these states the incidence of the infection is reported to be high and the disease severe in form, despite the fact that the climate is cool the year round. The total of 29,029 hookworms recovered from 280 residents of these states, who were treated to determine the degree of infection, gave an infection index¹ of 104. This is twelve points higher than the index for Java, where the disease was thought to be more wide-spread and more severe than in Brazil (Fig. 26).

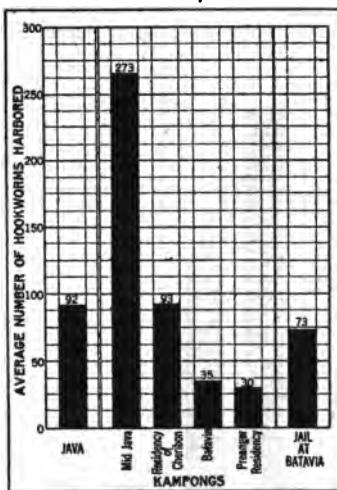


Fig. 26.—Hookworms harbored by three-hundred seventy-eight infected persons in Java. Distribution by localities

¹Average number of worms per case.

Worms Harbored by Brazilian Vagabond Boys. Nearly 11,000 worms were recovered from a group of eighty-one vagabond boys treated in the state of Rio de Janeiro. The counts ranged from two to 982; the average was 133. Another boy, who was too weak to receive the three treatments which were administered to the first eighty-one, expelled 1,912 worms as a result of the two treatments he was able to take. In a similar experiment among forty-five vagabond boys in the state of São Paulo, an average of 233 worms was obtained after treatment from nineteen boys who had always lived in the country, and an average of fifty-nine from twenty-six boys who had always been city residents.

Degree of Infection Among Agricultural Workers in Brazil. Townspeople are always more lightly infected than agriculturists.

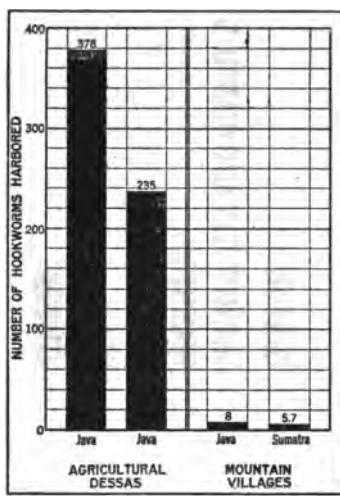


Fig. 27.—Comparison of number of worms harbored by agricultural workers and dwellers in mountain villages. Java and Sumatra

and are becoming interested in efforts to promote the health and working capacity of their laborers through treatment for hookworm disease and the prevention of soil pollution.

Severity of Infection Among Southern Troops in U. S. Army. Knowlton, in his work at Camp Jackson, South Carolina,

This is shown, for example, in Figure 26, page 65, which compares the infection indices of town residents, mountainers, and agriculturists in Java. The urban dwellers treated in Brazil yielded, on the average, less than fifty worms, while groups of farm laborers expelled from fifty-five to 233. From three adult farm workers in Guarulhos, 1,390, 1,031, and 405 worms apiece, or 972 average, was obtained. The average number of worms harbored by all workers on coffee plantations in the states of Rio de Janeiro and São Paulo doubtless reaches 160 or more; children under fourteen years of age living on these farms have been found to harbor as many as 365 worms. Coffee growers, and employers of agricultural labor in general, realize what this means as a cause of debilitation and inefficiency,

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treated for hookworm disease a large number of infected soldiers from the Carolinas and Florida. Among sixty-nine white and eighteen colored cases, the average number of worms obtained from the whites was 155.3; from the colored, 38.3. In a considerable proportion of the soldiers the infection was mild in form, but all grades were encountered, and in a few cases the infection was severe; three white patients yielded 1,010, 1,263, and 1,704 worms, respectively.

Through the means of the laboratory car *Metchnikoff* there were unsurpassed facilities for observing the effects of hookworm disease upon troops of the Southern Department of the United States Army, including recruits from the states of Texas, Oklahoma, Arizona, and New Mexico. Marked clinical symptoms were absent in 90 per cent of the men who, upon microscopic examination, were found to be infected; on treatment the number of worms expelled the first day by 80 per cent of the infected soldiers ranged only from one to five. This is an unusually light infection. The men dealt with, however, were between twenty and thirty years of age, an age period in which individual infections are dying out, and only a small proportion came from regions of heavy infection.

Correlation Between Number of Worms and Percentage of Hemoglobin. In general, there is definite relationship between the number of hookworms harbored and the amount of blood loss or anemia. This may perhaps be obscured by the resistance of the infected person, by abundant food, opportunities for rest, or by exceptionally active blood-forming processes, but the drain is none the less real and a constant tax on the vital powers. Thus, in the state of São Paulo, Brazil, during 1918, the average hemoglobin of six boys above fourteen years of age who harbored more than 400 worms each, was 63.7 per cent, as compared with an average of 72.7 per cent among forty-six boys of the same age who harbored less than seventy-five worms each. The normal hemoglobin of boys of this age is 84 per cent. Knowlton found, in his work among soldiers at Camp Jackson, South Carolina, that no severe reduction in hemoglobin was caused by less than 500 worms. The hemoglobin of thirty-three of his patients each of whom had fewer than this number of worms, was between 80 and 89 per cent.

Importance of other Factors which Lower the Hemoglobin Index. Of course, not all anemia encountered among the people in infected regions is to be attributed to hookworm disease. Malaria and underfeeding, to say nothing of other devitalizing diseases and conditions, play important parts. The hemoglobin index of all 109 prisoners in the jail at Batavia, Java, for example, was 25.8 points below the normal 95 per cent. Experiments indicated that a loss of 6.8 points was due to hookworm disease, of 10.3 to malaria, and of 8.0 to hard labor. Again, in Fiji, where there is no malaria, underfeeding resulted in a group of East Indians having 9.5 per cent lower

hemoglobin than another well-fed group of the same race. Both groups harbored the same number of hookworms.

Varying Effect of Equal Numbers of Worms Upon Men, Women, and Children. The Board's Uncinariasis Commission to the Orient, working with large numbers of persons from whom practically all hookworms had been expelled by vermicide and counted, found that on the average, in the presence of the conditions that obtained in the areas dealt with, twelve hookworms caused a reduction of 1 per cent in hemoglobin. An equal number of worms produced more anemia among children than among women, and more among women than among men. Furthermore, when the types of infection resulting from equal numbers of *Ancylostoma duodenale* and *Necator americanus* were compared, it was found that the former produced a more severe form of the disease than the latter.

II

EFFECTS OF HOOKWORM INFECTION

Hookworm infection works subtly through long periods of time. Its cumulative effects are handed down from generation to generation. The disease destroys economic efficiency and social development on the one hand, the while it undermines physical and mental health on the other. It is a menace and an obstacle to all that makes for civilization. As a handmaiden of poverty, a handicap of youth, an associate of crime and degeneracy, a destroyer of energy and vitality, it stands in the very forefront of diseases. Its effects express themselves in stunted physical and mental growth, blighted health and efficiency, retarded economic progress, and general degeneracy and decay. Labor is impaired, home standards are lowered, mental development is inhibited, and there is a tendency for the human machine to wear out before its time. Wherever treatment is systematically carried out and followed by rigorous control of further infection, marked improvement in health and general capacity results.

PHYSICAL RETARDATION

Hookworm disease saps the strength by such imperceptible stages that usually the patient himself does not sense any change in his physical condition from day to day, until his powers of resistance eventually become so lowered that the germs of tuberculosis, of pneumonia, of typhoid fever, or of some other acute infectious disease find favorable lodgment, and all too frequently a fatal outcome results. Statistics show that the mortality rate of hookworm is greatly exceeded by the rates of the more spectacular diseases. But by its steady sapping of the strength of millions of people, continued without interruption over many generations, hookworm disease causes human misery and suffering of a much more severe character than its low death rate would lead one to expect.

Retardation as Measured by Hemoglobin Content. In Costa Rica, Nicaragua, Panama, and a number of other countries,

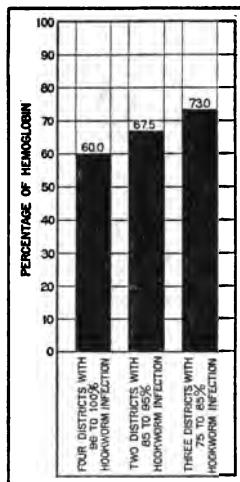


Fig. 28.—Relationship between percentage of hookworm infection and hemoglobin index. Nine districts of Porto Rico

blood examinations have been made with a view to determining approximately the degree of anemia which is associated with the infection. Among a total of 194,021 persons whose blood has been examined to date, three-fifths had a hemoglobin index below 70 per cent. By far the largest number of cases in any single group (91,190) fell between 50 and 69. Twenty-two thousand, six hundred cases were between 30 and 49, while 2,842 were between 10 and 29, and 226 were below 10. Of course not all this anemia is due to hookworm infection, as hard labor, underfeeding, malaria, and a number of other devitalizing diseases and conditions play their parts in impoverishing the blood.

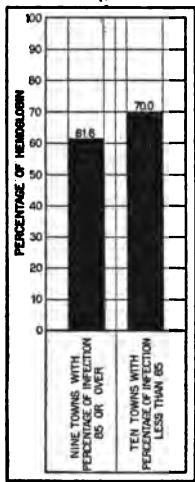


Fig. 29.—Relationship between percentage of hookworm infection and hemoglobin index. Nineteen towns in state of Minas Geraes, Brazil

those after treatment, of 76 per cent.

That the hemoglobin index continues to rise for a considerable period following the close of regular campaign measures, is suggested by observations made on the estate of Rodeo, in the canton of Mora, Costa Rica. On this estate the average hemoglobin index of persons just cured was 63.3. In a re-survey conducted two years later, it was 76.8 among the persons remaining uninfected.

¹ It would, of course, be preferable to confine the comparison before and after treatment to the same number of persons. However, since the cases examined after treatment were taken at random and large numbers were involved, the figures are doubtless sufficiently accurate for practical purposes.

Increase in Hemoglobin Following Treatment. From a number of countries, distinct gains in hemoglobin have been reported among groups of infected persons after treatment for hookworm disease. In Porto Rico, the average hemoglobin as estimated for the total population over a large area where the test was made, was raised from 43 in 1904 to 72 in 1914; in Dutch Guiana the average hemoglobin in a group of infected persons was 71 before treatment and 90 six months or more afterward; in five towns of Nicaragua the hemoglobin index of infected persons rose from 61 to 74 as a result of treatment; in two areas of Panama, from 59 to 68; and among a small group in Chiangmai province, Siam, from 65.5 to 77.5.

During 1917, 1918, and 1919, the director of the work in Costa Rica had opportunity to test the blood of 62,124 infected persons before treatment for hookworm disease, and of 21,787 of the same persons (35 per cent) six months or more after they had been treated.¹ The examinations before treatment showed an average hemoglobin of 64 per cent;



Fig. 30.—Retardation in growth, due to hookworm disease. Two sisters, one on left twenty-one years old and heavily infected; one on right seventeen years old and lightly infected. Ceylon



Fig. 31.—Tamil boy, before treatment for hookworm disease. Age 7, weight 32 pounds, hemoglobin 60 per cent. Bed-ridden for nearly a year



Fig. 32.—Same boy as Fig. 31, six months later, after being cured of hookworm disease. Able to participate in boyish games

Gain in Body Weight by Siamese Soldiers. It is customary for striking gains in body weight to follow treatment for hookworm disease. Such improvement in individuals has often been noted, and large numbers of separate instances could be cited of remarkable increases in weight within short periods of time. During 1918, Hluang Boriracksha, of the Siamese Army Medical Service, made observations on ninety-nine soldiers of the Siamese Army. All of these men had hookworm disease. Sixty-nine of them were treated once with fifty grains of thymol. The other thirty were given no treatment whatever. The treated men gained an average of 10.6 pounds in weight over a period of one year, while the untreated gained during the same period an average of only 1.1 pounds.

Hookworm as a Factor Predisposing to Other Diseases. The 1918 influenza epidemic in Ceylon showed that on all the estates embraced within the Maskeliya area, with a total laboring population of 17,838, the death rate from influenza and its sequelae was twice as high among persons who had not been treated for hookworm disease as among those who had. The deaths numbered 111, or 7.5 per thousand, among 14,659 persons who had been treated for hookworm infection before being attacked by influenza, as compared with 43, or 13.8 per thousand, among 3,253 persons who had not been treated for hookworm. Similarly, Major Kofoid, of the United States Army Medical Service, reports that the hospital statistics and sickness records of 24,000 men at Camp Bowie during the period from October, 1917, to May, 1918, indicated that the resistance to disease was lowest and the mortality rates were highest among the organizations in which hookworm disease was most prevalent.

Reduction of Morbidity Following Hookworm Campaigns. That improved health follows treatment for hookworm disease is illustrated by the following instances:

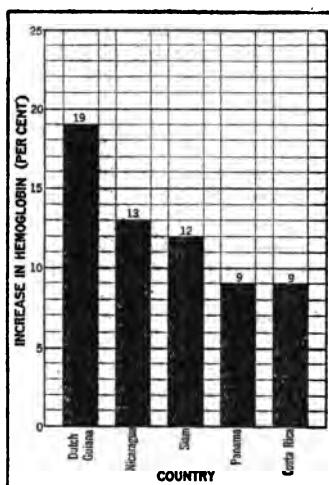


Fig. 33.—Increase in hemoglobin following treatment for hookworm disease.* All countries

* The figures indicate the difference between the hemoglobin index of infected persons before treatment and their index after treatment.

a. Decrease in admissions to estate and asylum hospitals in Trinidad. On one estate in Trinidad, as well as at the Orphanage and Industrial School located at Tunapuna in that colony, sanitary reform and the treatment of infected persons reduced by two-thirds the number of patients admitted to hospital. The work in the Orphanage was completed in April, 1916. During the last two months of the year, only three patients were admitted to the hospital, as compared with a monthly average of forty admissions for the previous four years. In another institution in the same colony, the Boys' Reformatory, the regular hookworm control measures were completed in March, 1918. Before the boys had received treatment for hookworm disease, sixty or seventy ulcers had to be dressed daily; two months after treatment had been begun only seventeen ulcers remained, and of that number, only three were serious enough to require much attention.

b. Diminished sickness in areas of British Guiana. From the Peter's Hall and Belle Vue districts of British Guiana, where operations against hookworm disease were in progress during 1914 and 1915, the number of patients admitted to the public hospital at Georgetown during 1916 was 31.5 per cent lower than during 1914. In contrast with this, the reduction for rural districts in which measures against hookworm disease were not carried out, was only 6.5 per cent.

On one estate in this colony the amount of sickness had increased to such an extent that before the laborers were treated for hookworm disease an addition to the estate hospital was planned. As a result of the hookworm campaign which intervened between the planning of the addition and its erection, the addition was found unnecessary. So great was the reduction in the sickness after hookworm disease had been treated, that even the original quarters were seldom filled to capacity.

c. Lowered record of sickness calls on Ceylon estates. On seven estates of Ceylon there was a decrease of 1,132 sickness calls, or 44 per cent, for four months of 1917, following treatment of the laborers for hookworm disease, as compared with the same four months of 1916, before the laborers had been treated for the disease. The largest reduction occurred in the calls for second and third treatments, indicating that the improvement in health effected by treatment for hookworm disease resulted in the patients being more readily cured of all their maladies. The decrease in bowel complaints and in malarial fevers among the coolies on these estates was especially marked.

In another area the District Medical Officer reported that only 2,604 patients were admitted to hospital in 1918, after treatment for hookworm disease had been carried out in his locality, as compared with 3,694 in 1916, before systematic work against the disease had been begun. This represents a reduction of 27 per cent in the number of hospital admissions.

d. Lessening of sickness absenteeism on Indian tea estates. The investigation conducted by Lieut.-Col. Clayton Lane in the Darjeeling district in India showed that treatment resulted in noticeable improvement in the health and efficiency of labor. One manager wrote Dr. Lane that during the three months preceding the campaign against hookworm disease, at least forty-five men were continuously absent from work because of sickness. During the same three months of the following year, after the hookworm campaign, only twenty-six men were laid off for this reason—a reduction of 42 per cent. Another manager reported that prior to the time treatment was given his laborers, between 150 and 200 of them were absent from work daily during the rainy season. In 1918, after treatment had been administered, the number daily absent from work during the rains never exceeded sixty, and usually was considerably less than this figure.

Effect of the Disease on the Birth Rate. It is probable that hookworm disease has a deterrent effect upon the birth rate. Not only do the sterility and impotence commonly caused by the infection reduce the frequency of conception, but the effects of the disease, falling most heavily on women of child-bearing age, cause a large proportion of the pregnancies that do occur to terminate in abortions or miscarriages. Wherever treatment is carried out over large areas, the birth rate is stimulated in marked degree. Many women become pregnant who have not borne children for years. The regularity of menstruation is restored, sterility reduced, the number of pregnancies correspondingly increased, and the proportion of unfavorable terminations reduced. This is a fact of vital economic significance in view of the present shortage of man-power throughout the world.

MENTAL RETARDATION

During 1918 the Ministers of Public Instruction in Nicaragua and Salvador issued decrees calling for the examination of all school children for hookworm disease and for the treatment and cure of those infected; and the Prefect of the Federal District of Brazil, similarly, ordered the examination and treatment of the pupils in the public schools of the city of Rio de Janeiro. These acts were prompted by recognition of the fact that aside from its baneful influence in retarding physical development, hookworm disease causes a further loss to the state by impairing the intellectual character and capacity of its citizenship.

Comparative Scholarship Gradings of Infected and Non-Infected. Lists of the children found infected usually correspond with those of the dullest pupils in their grades. In one women's college in the Southern States, for example, the average standing of fifty-six students found infected was 78 per cent, whereas fifty-six students found free of infection averaged 89 per cent. In another

instance, twenty-five infected boys in a Southern academy averaged 64 per cent in their studies, as compared with the percentage of 86 maintained by the same number of non-infected boys. Here the retardation was approximately 25 per cent. Teachers everywhere are practically unanimous in reporting that treatment of the infected pupils results not only in marked gains in weight and physical appearance, but in decided improvement in zeal and intelligence as well.

Mental Retardation from Hookworm Disease in U. S. Army. Major Kofoid reports, on the basis of his experience with hookworm disease among troops in the Southern Department of the United States Army, that when the findings of the hookworm survey were compared with those of the psychological board in the case of 10,000 men at Camp Travis, Texas, the mentality of white men with hookworm disease was found to be about 33 per cent below the mentality of those without it.

Study of Mentality of Infected Children in Queensland. During 1918 a thorough investigation was made of the mental retardation due to hookworm infection among the school children of Queensland, Australia. The study was made possible by the Queensland Department of Public Instruction, which provided a school nurse for six months and all necessary facilities for carrying out the work. Three hundred forty children between the ages of six and fourteen years were selected for mental testing. As far as possible, effort was made to obtain a fair representation of the 5,000 or more school children residing within the areas visited, both as to strata of society and the sections of town or country from which they came. The children

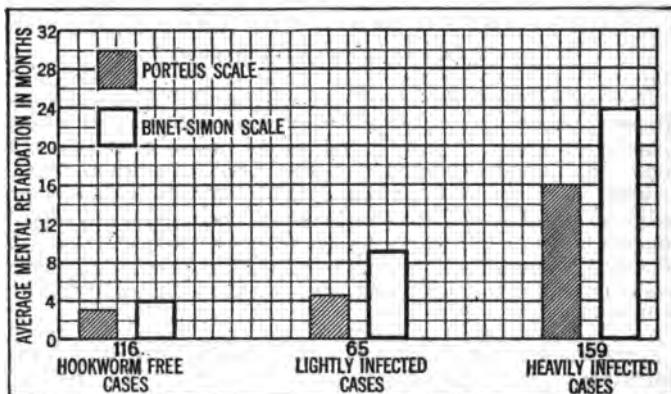


Fig. 34.—Comparative mental retardation, in months. Hookworm free, light hookworm infections, and heavy hookworm infections. Three hundred forty school children of Queensland, Australia. 1918

selected fell naturally into one of three groups, according as microscopic examination of the fecal specimens which they submitted showed that they were not infected, only lightly infected, or heavily infected, with hookworm disease.

Measures of Mentality Employed in Queensland Study. The method of selection on the basis of stool examinations kept a constant factor of other causes of retardation, such as hereditary mental defects, syphilis transmitted from parents, parental alcoholism, tonsils and adenoids, and so forth. The tests were applied by the nurse, without knowledge as to what result the microscopic examination of the child's feces had yielded. Goddard's revision of

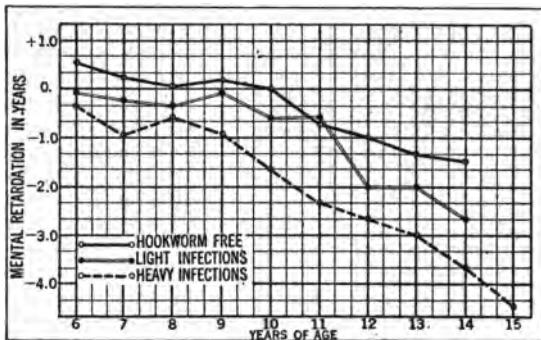


Fig. 35.—Results of Binet-Simon mental tests by age groups. Three hundred forty school children, Queensland, Australia. 1918

the Binet-Simon tests, the Porteus mazes, and a special modified dot-counting test were employed in gauging the mentality of the children. In using the Binet-Simon tests, special adjustments were made to adapt them to Australian children. From thirty-five to forty minutes were taken for applying the tests to each child.

Findings of Queensland Mental Retardation Study. Figs. 34 and 35, pages 76 and 77, exhibit graphically the principal facts disclosed by the survey. Lightly infected cases had, on the average, a retardation of 9.3 months in their mental development as measured by the Binet-Simon tests, and of 4.9 months as measured by the Porteus; while heavily infected cases were retarded 23.4 months as measured by Binet and 16.6 months as measured by Porteus. The longer the infection had persisted in the child, the greater was the retardation found to be. Thus, in infected children eight years old the retardation was only 6.6 months, while in those eleven years old it was 19.0 months and in those fourteen years old, 25.9 months. In extreme cases accompanied by the most severe types of individual infection, a retardation of as much as five years was recorded.

III

DIAGNOSIS OF HOOKWORM INFECTION

Measures for the relief and control of hookworm disease, to be of the greatest value, must be conducted in such manner that their benefits will not only reach the more advanced and prosperous peoples, but also extend to the many millions of primitive folk who

inhabit the more remote and inaccessible regions of the earth. This means that field activities must often be carried out under conditions far from ideal. In all of the Board's work the aim has been to achieve accuracy and simplicity. If the latter requirement is to be met, the apparatus and equipment cannot be elaborate, nor should extensive preliminary training on the part of the examiners be necessary. Another cardinal point is to keep the expense within the means of the community; otherwise there can

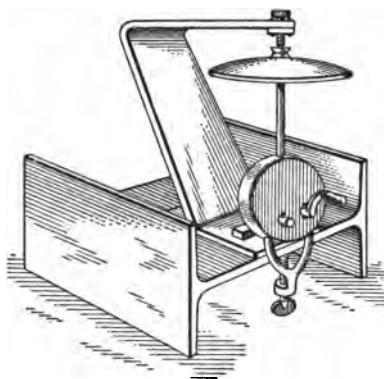


Fig. 36.—Winsor's stand for increasing speed of centrifuge

be no world-wide hookworm control.

Methods of Diagnosing the Infection. The disease may be diagnosed by administering a vermifuge and searching the stools for hookworms, or the vermifuge may be omitted and specimens of feces may be microscopically examined for ova. It has been customary to rely almost entirely upon several variations of the latter method. There are also various culture methods for demonstrating the infection, but these are hardly practicable for extensive use in the field.

How Fecal Specimens are Received and Examined. When microscopic examination of the feces is the basis for demonstrating the disease, every person in an infected area is invited to submit a specimen of his feces for examination. For this purpose are supplied small tin boxes about one inch in diameter, with the lid of each properly marked for identification. Every effort is made to insure careful and accurate diagnosis of the specimens submitted. In each country the examiners are native young men who have been especially

selected for their reliability, and carefully trained in the detection of ova. The specimens found negative by one man are in almost all cases re-examined by one or two others, and head examiners are usually employed to watch over the work and safeguard the accuracy of the results.

MICROSCOPIC DIAGNOSIS WITH PLAIN SMEAR

Until 1914 the plain smear method of microscopic examination was used almost exclusively. This consists of the careful search of not less than three smears from each specimen before pronouncing free of infection the person who submitted it. The glass slides on which the smears are examined measure not less than $1'' \times 3''$. The disadvantage of this method lies in the fact that it requires more time for thorough examination than can well be devoted to each specimen. Furthermore, the specimens themselves are too small to yield entirely trustworthy results. Nevertheless, the method gives fairly good results when large or moderate numbers of the parasites are harbored.

DIAGNOSIS WITH THE AID OF THE CENTRIFUGE

When only a few worms are harbored, the number of eggs in the feces is, of course, correspondingly reduced. It then becomes necessary to employ a ready means of concentrating the eggs, not merely to facilitate the search but also to insure a greater degree of accuracy in the findings. In recent years a multiple-tube hand centrifuge, which goes far toward meeting these needs, has come into general use. When this machine is employed, two or three slides from each specimen are first examined by the ordinary plain smear method. Those specimens which seem to be negative by this process are set aside and centrifuged in groups of twenty; and from the concentrated sediment thus obtained, two or three slides are usually prepared from each specimen for further examination with the microscope. Experiments have shown that the number of specimens found positive is about 20 per cent higher when the centrifuge is used than when the ordinary plain smear method alone is relied upon for diagnosis.

Use of Centrifuge Stand. Dr. S. A. Winsor, in Ceylon, found that by the use of a stand such as is pictured in Figure 36, page 78, the speed of the centrifuge may be considerably increased. The increased speed causes the ova containing sediment to adhere more closely to the cork at the lower end of the centrifuge tube. The close packing insures against the possibility of a considerable portion of the sediment falling back when the tube is tilted to remove the cork.

METHOD OF EMULSIFYING STOOLS FOR CENTRIFUGATION

According to the usual method of preparing stools for centrifugation, a small quantity of feces—4 to 5 grams—is placed in a flat-bottom glass vial. To this specimen is added ten or more times its bulk of water. The water and feces are stirred together until an emulsion is made. The emulsion is then poured into a centrifuge tube through a glass or paper funnel in which are placed two or three layers of gauze, which serve to remove the larger particles from the fluid.

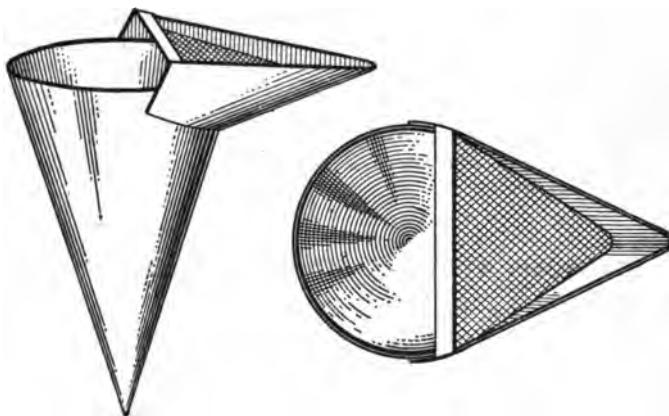


Fig. 37.—Waite's special grooved tin cone for pouring fluid stool into centrifuge tube

Dr. J. H. Waite devised a method of emulsifying stools in which he substituted for the glass mixing vial a tin cone grooved at the top to facilitate pouring a small stream of fluid stool into the centrifuge tube (Fig. 37). This method obviated the need of a funnel. The cones are cheap, unbreakable, and easily packed for transportation. They allow more rapid and more complete emulsification of the stool than a flat-bottom vial, because the unbroken stool particles gravitate to the apex of the cone where they can easily be macerated with a tooth pick.

During 1919 a director in Ceylon devised an improvement for this apparatus, in the form of a fine-mesh strainer which is fitted into the groove through which the feces are poured into the centrifuge tube.

Levitation Method of Preparing Slides from Centrifuged Specimens. Clayton Lane recommends a new technique of slide preparation, which he designates the "levitation method." Accord-

ing to this procedure the concentrated sediment of the centrifuged specimen is transferred to a glass slide, where it is thoroughly mixed with one mil of water and spread out evenly over an area within the limits of the range of the mechanical stage. The slide is allowed to stand for five minutes, and is then immersed in water and manipulated until all coarse matter has floated free. By this process nearly the entire amount of obscuring matter can be removed and, owing to the tendency of hookworm ova to stick to a slide after once settling, very few eggs are washed away. Lane reports that, on an average the levitation method results in a ten-fold concentration of ova. By its use it has been found possible to collect and count upon a slide area of 2 x 1 inches, 2,227 hookworm ova from a stool specimen of one-half mil.

Accuracy of Centrifuge Method. The accuracy of the centrifuge method, like that of the plain smear method, depends primarily upon a fecal sample that is too small to yield entirely trustworthy results. The Board's Uncinariasis Commission to the Orient found, in the Federated Malay States and in Fiji, that when the same groups of persons were examined first by the centrifuge method and later by administering a vermifuge and straining the stools for worms, the microscope showed only from 75 to



Fig. 38.—Special type of hand centrifuge used in examining specimens (Top) Stewart panhead, with specimen tubes in position (Bottom) Shaft showing manner of clamping to table

85 per cent of the persons examined to be infected, while diagnosis by vermicide revealed from 94 to 100 per cent. It seems well within conservative bounds to estimate that in examinations both before and after treatment, diagnosis by microscopic examination, aided by the centrifuge, yields evidence of infection varying from 4 to 25 per cent less than that which actually exists. In support of this statement the evidence afforded by experiments made in Brazil during 1918 may be cited.

Summary of Experiments in Brazil During 1918. One hundred and two among the total of 280 test cases treated in Brazil during 1918 were reported negative on original microscopic examination; thus the percentage of infection was 63.6. All 102 of the negative cases were later treated and fifty-six of them expelled worms, so that the actual rate of infection was not less than 83.6. All of the original examinations were made by trained microscopists with the aid of the centrifuge, and yet the result shows a difference of 20.0 per cent in favor of diagnosis by vermicide. The fifty-six cases incorrectly diagnosed yielded 716 worms, or thirteen per infected case. One of the cases declared negative on microscopic examination expelled as many as 115 worms.

GLYCERINE-SALT PROCESS OF EXAMINATION

It seems that infections which escape detection by the combined plain smear and centrifuge methods represent cases which harbor comparatively few worms. Nevertheless it is of considerable importance that these mild infections be correctly diagnosed.

Two special techniques of examination have lately been developed to meet this need: the glycerine-salt and the brine flotation-loop method. Both make use of specific gravity as an aid to correct diagnosis. The former was developed by Dr. M. A. Barber in his work in the Federated Malay States, and was used by the medical officer in charge of the work in Siam in examining 31,298 specimens in that country up to December 31, 1918. The results obtained from its use are reported to be extremely satisfactory.

Process of Examining by Glycerine-Salt Method. In using the glycerine-salt technique, a diluting fluid composed of equal parts of a saturated solution of magnesium sulphate and glycerine is prepared. This fluid is dropped from a large dropping-bottle into the small tin box which contains the specimen. The fecal mass is thoroughly stirred and broken up with a toothpick, which releases the ova and causes them to rise to the surface. The upper part of the fluid in each container is poured upon a 2" x 3" glass microscope slide which has been rimmed with paraffin or grease, and the surface of the slide is searched for eggs. The entire contents of a container can be examined by preparing three or four of these

slides. The process regularly followed is to examine two slides before and two after centrifuging the specimen. The glycerine-salt diluting fluid is used in preparing all four of the slides, including those made before as well as after centrifuging.

Advantages of the Glycerine-Salt Method. The number of ova brought upon the slide by the glycerine-salt method is so greatly increased that the eggs can be much more easily found than when the plain smear method is used. This reduces the number of specimens that have to be run through the more time-consuming process of centrifuging, and results in a great saving of time. This is an especially important consideration in regions like Siam, where the individual infection is so mild that when the plain smear method is used it is often necessary to prepare from ten to twelve slides from a single specimen and to spend from twenty to thirty minutes making a diagnosis.

Comparative Accuracy of Plain Smear and Glycerine-Salt Methods. Forty-five test specimens were examined personally by the director of the work in Siam, who used first the plain smear and then the glycerine-salt method. Two slides from each specimen were examined by each method; in neither case was the centrifuge used as an aid. The percentage of persons found infected in examinations by the plain smear method was 23.3 by the first and 12.2 by the second slide, or 35.5 by the two slides combined. By the glycerine-salt method it was 84.4 by the first and 2.2 by the second, or 86.6 by both slides. With the plain-slide technique a total of thirty-six ova were found on all ninety of the slides examined; with the glycerine-salt technique, a total of 448.

A later series of forty-three specimens was examined by the two methods, but a second slide was prepared only when the first proved negative, and no record was kept of the number of eggs discovered. In this series the percentage found positive by the plain slide method was 37.2, as compared with 67.4 by the glycerine-salt method. For both series, embracing eighty-eight specimens in all, the percentage of positive findings by the two methods was 27.5 and 77.2, respectively.

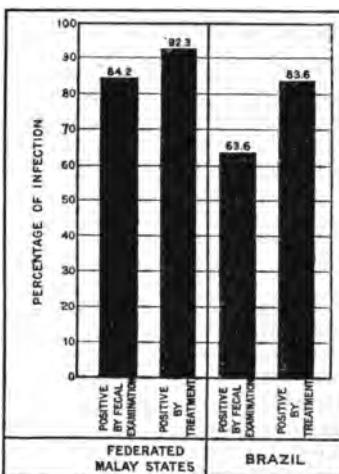


Fig. 39.—Comparative accuracy of diagnosis by fecal examination and by vermicure treatment. Based on tests in Federated Malay States and in Brazil

Accuracy of the Plain Slide, Centrifuge, and Glycerine-Salt Methods Compared. Twenty-seven of the eighty-eight specimens just mentioned were examined in rotation by the plain slide, centrifuge, and glycerine-salt methods. In this series, record of the number of ova discovered was omitted, and a second slide was not prepared if the first proved positive. The results showed that the glycerine-salt was the most accurate of the three methods. The findings were as follows: 40.7 per cent positive by the plain slide, 55.5 by the centrifuge, and 70.2 by the glycerine-salt method.

BRINE FLOTATION-LOOP METHOD OF EXAMINATION

During 1918 Majors Kofoid and Barber developed a special technique known as the "brine flotation-loop method," and employed it in examining for hookworm disease the soldiers in the Southern Department of the United States Army.¹ This method is in part an outgrowth of experience with the glycerine-salt method just described. In the army medical work it was used by about seventy-five examiners in making more than 100,000 examinations under field conditions, and was found to be rapid, efficient, practicable, and especially valuable in diagnosing light infections.

Technique of Examination With Brine Flotation-Loop Method. The process followed in making examinations by this method is to mix a large fecal sample thoroughly in concentrated brine in a paraffin paper container of from 50 to 75 mils (2 to 3 ounces) capacity. The coarse float is forced below the surface by means of a disk of No. 9 steel wool, and the container is allowed to stand one hour for the ova to ascend. The surface film is then wiped off with wire loops $\frac{1}{2}$ " in diameter and examined on a slide without a cover glass. The ova of hookworms and of other parasites are floated up by the brine into the surface layer of the pool without distortion or noticeable change in appearance.

Advantage of Flotation-Loop Process. The great advantage of this method is believed to lie in its easy utilization of large samples. With containers of sufficient size, receptacles for mixing the entire stool can be employed. This eliminates the element of random sampling, except in so far as this may be due to irregular egg-laying by the female worms or to an unequal discharge of eggs in successive stools. It insures also a sufficient number of ova to make detection possible in infections light enough to be overlooked by other methods using smaller samples. It is for this reason a more accurate means of diagnosis. In addition, it is reported to be about 50 per cent more rapid than the centrifuge method.

¹ For full particulars, see article entitled "Rapid Method for Detection of Ova of Intestinal Parasites in Human Stools," by Charles A. Kofoid and Marshall A. Barber, Journal American Medical Association, vol. 71, No. 19, p. 1557.

Accuracy of Flotation-Loop Process. The accuracy of this method depends on a number of variables, including the size and consistency of the specimen, the thoroughness of stirring, the amount of steel wool used, the care in looping, the opacity of the fluid, and the extent and thoroughness of the search made of the material on the slide. Eight lots of fifty specimens each, which had been examined once, were set aside and subsequently re-examined for the purpose of ascertaining what proportion of light infections had escaped detection. The specimens were all from companies of soldiers in which there was light and therefore presumably easily-overlooked infection, and all had been found negative on the first examination. The top float of each of fifty cans was drawn off into a tall cylindric liter graduate, and the surface film of this column was examined. The cans had stood, after stirring, for not less than two or three hours. In order to avoid entangling any ova that might be present, no brine from thick or viscous stools was used. Only one specimen among all eight lots, or one in 400 negatives, was found positive on second examination. From this it appears that the number of positive escaping detection by this method is practically negligible.

CALDWELL MODIFICATION OF THE FLOTATION-LOOP METHOD

Dr. F. C. Caldwell calls attention to two difficulties which present themselves when the brine flotation-loop method of examination is used in the ordinary field work of the International Health Board. First, the large amount of fecal material required by this technique necessitates a mixing container of more than regulation size; and secondly, the time required to secure adequate comminution of each specimen renders the method tedious under field conditions where a large number of specimens are to be examined.

Special Caldwell Comminution Apparatus. During 1919 Dr. Caldwell devised an apparatus which obviates the foregoing difficulties by providing for the thorough comminution of a number of specimens at one time and by permitting the use of the regulation container. The apparatus consists of two pieces (plates) of wood or metal joined by means of two bolts. The upper plate contains sockets for ten tubes of sufficient size to hold the ordinary specimen containers. The tubes used in the apparatus are closed at one end, and each socket of the upper plate is provided with a thin layer of cork so that when the apparatus is fastened together the tubes are sealed. Containers holding fecal specimens are dropped into the tubes. A few pieces of shot are added to each container, and the tubes are filled to three-quarters of their capacity with concentrated salt solution. The upper plate is then screwed into position and the apparatus is thoroughly shaken. After this process the floating

matter is removed and prepared for examination according to the Kofoid-Barber technique. In the laboratory tests in which the apparatus has been used, it has been found to give a much better concentration than the centrifuge; and since it permits of the use of a large amount of material, it gives a more decisive test.

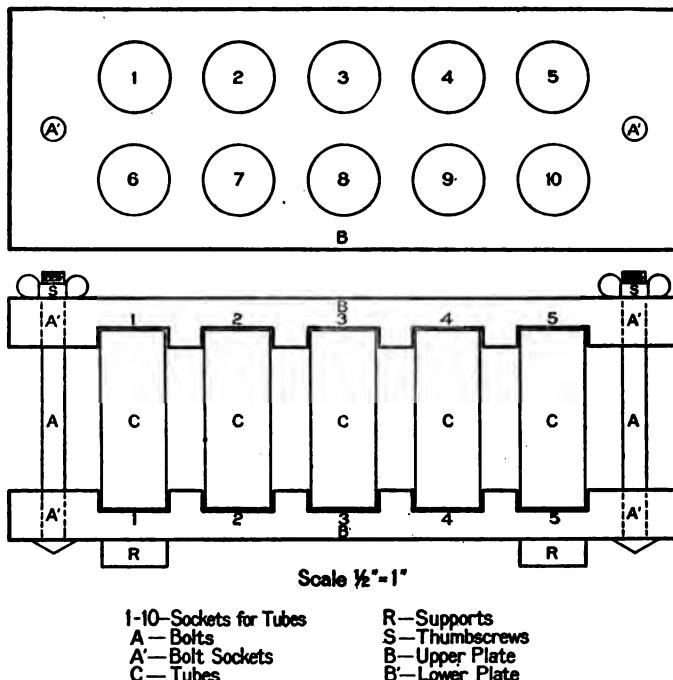


Fig. 40.—Caldwell's apparatus for facilitating comminution of feces

WINSOR VARIATION OF THE FLOTATION-LOOP TECHNIQUE

Dr. S. A. Winsor, in his work in Ceylon during 1919, found that with the use of the ordinary brine flotation-loop process considerable difficulty was experienced in preserving the contour of the egg and in eliminating from the floating matter of the fecal emulsion substances which obstructed the microscopist's view of the ova. By the use of the following technique he has been able largely to over-

come these difficulties. In an ordinary mixing cone, about ten grains of feces are thoroughly stirred with ten drops of water. The cone is then filled to three-quarters of its capacity with saturated sodium chloride solution containing 1 per cent of commercial acetic acid. A thin layer of absorbent cotton is spread over the top of the mixing cone, with the margins overlapping the edge, and is pressed down as far as possible with a wire loop. The fecal emulsion containing ova rises above the cotton, while the larger floating particles are eliminated. The emulsion is poured into a concentrator and allowed to stand from ten to thirty minutes before being transferred to a slide for examination. If permitted to remain longer in the concentrator, the eggs tend to become crenate and scarcely recognizable.

IMPRACTICABILITY OF SCIENTIFICALLY EXACT DIAGNOSIS

When a person is declared free of infection on microscopic examination, the term "free of infection" is used in a relative sense to indicate that the number of worms in the intestines is so small that no ova can be discovered in the feces. This does not necessarily mean that there is not a single hookworm present. Male worms may still be harbored, as there is no possible way of knowing that none of these remain except by administering repeated treatments and washing the stools after each treatment. Nor is it possible to say that not a single female worm inhabits the intestinal tract unless specimens of stool are examined every day for many days for the presence of ova. But it can be stated definitely that if careful examination by the methods in use fails to show the presence of ova, the number of worms remaining is very small. If patients are willing to submit two or three specimens for examination, the removal of every parasite could be more definitely predicated, but this would entail a large amount of additional work and present many difficulties if attempted under field conditions.

DIAGNOSIS BY ADMINISTRATION OF VERMIFUGE

The most accurate method of diagnosing hookworm infection is by administering vermicidal treatment and examining the stools for the presence of worms. This method of diagnosis is of especial value for determining both the type of hookworms harbored by patients and the degree to which the latter are infected. It is not, however, practicable as a routine field measure. The procedure employed by the Uncinariasis Commission to the Orient, when diagnosing infection by this method, was as follows:

On the morning of the day preceding treatment the persons to be examined were allowed their usual diet. In the afternoon they were given some rice and gruel and a half pint of milk, and at 5:00 p. m.

a purgative was administered. On the morning of treatment, food was generally withheld, although in some cases a little milk was permitted. The vermifuge was administered in three doses at hourly intervals. Two hours after the last dose a second purge was given. At 12:30 noon the patients were allowed to drink milk, and in the afternoon they were given a little rice and bread. The next day they were allowed rice and curry, but vegetables with coarse fibers were prohibited because they might have interfered with the search for worms. Stools were examined for worms until seventy-two hours had elapsed. Six stools per case were usually obtained during this period.

Method of Washing Stools. A regular routine was followed in the washing of stools. Those that were soft or fluid were washed at once; the more compact stools were mixed with water and stirred until soft. The washing was done by means of a jet of water played with moderate force into a large brass wire sieve (mesh 50 to an inch) into which the feces had been poured. The washed stool was distributed into photographic developing trays, a small portion into each tray. A dark brown tray was found to furnish the best background for the worms. These were then picked out with needles or forceps and placed in properly numbered Petri dishes containing normal salt solution. Later the excess salt solution was drained off and the worms were killed by flooding the dishes with boiling alcohol (70 per cent). When the worms are scalded they become rigid and assume the shapes that are characteristic of their species. This renders differentiation comparatively easy and the worms can be rapidly counted.

IV

METHODS OF TREATING HOOKWORM DISEASE

The principal remedies used in the treatment of hookworm disease are chloroform, eucalyptus, beta-naphthol, thymol, and oil of chenopodium. A new drug known as *carvacrol* was tried during 1918, but the results attending its use were reported as unsatisfactory. Of the five drugs most extensively employed, thymol and oil of chenopodium have proved themselves superior to all the others under field conditions. Chenopodium during recent years has been gaining steadily in favor.

Comparative Efficiency of Thymol and Chenopodium. In a number of experiments conducted by the Board's Uncinariasis Commission to the Orient, for the purpose of reaching a scientific conclusion as to the relative merits of chenopodium and thymol for routine treatment, chenopodium in small doses proved more efficacious than small doses of thymol. In larger doses the drugs showed approximately equal efficacy in removing Necator, but chenopodium proved superior to thymol in removing Ancylostomes, the more resistant species of hookworm. There was failure to cure the patient (by removing all hookworms harbored) in 23.6 per cent of the cases treated with thymol, as against only 7.6 per cent of the cases treated with chenopodium. A test vote taken in the course of the work indicated that nearly all patients preferred chenopodium as being less unpleasant to take than thymol.

Relative Cost of Treatment with Thymol and Chenopodium. When the treatment of large populations is contemplated the comparative cost of the drugs employed is an important consideration.

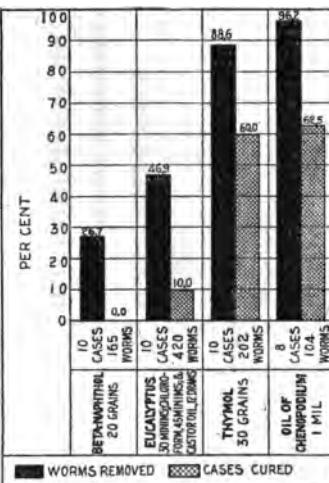


Fig. 41.—Comparative efficacy of beta-naphthol, eucalyptus, thymol, and oil of chenopodium. Based on experiments with thirty-eight cases in studies of Uncinariasis Commission to the Orient

A series of experiments designed to furnish an estimate of the relative cost of treatment with chenopodium and thymol, was conducted by the Uncinariasis Commission to the Orient in February, 1917. At this time the price of chenopodium was 1.84 cents per mil, and the price of thymol was 0.15 cents per grain. The dosage of chenopodium which proved most satisfactory as a routine vermicide was 1.5 mils administered in three equal doses of .5 mils each. On this basis the cost per individual for the chenopodium treatment amounted to 2.76 cents. The dosage of thymol which proved to be most satisfactory was one treatment consisting of 60 grains divided into three equal parts. With this treatment the cost of thymol per individual was 9.0 cents. It will be seen therefore that the cost of treatment with chenopodium was less than half as much as the cost of treatment with thymol (Fig. 42).

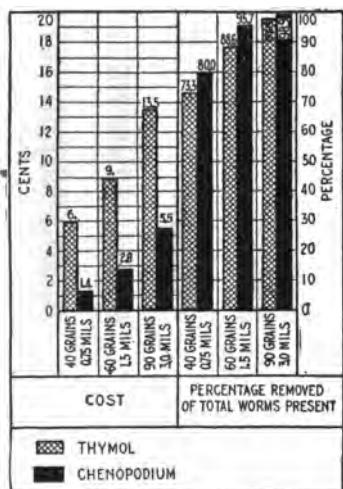


Fig. 42.—Relative cost and comparative efficacy of thymol and chenopodium. Based on studies of Uncinariasis Commission to the Orient

treatment, when previous treatments had been well supported. The oil was paler in color and of less density than the ordinary product, and was characterized by an extremely acrid odor. Samples of this oil were secured and submitted to Dr. E. K. Nelson, of the United States Department of Agriculture, who is now engaged in a series of studies which it is hoped will throw light on the varying efficacy and toxic effects of different specimens of the oil. Until such time as proper standardization of the drug can be effected, it seems advisable to repeat the earlier caution that medical officers should exercise careful supervision over the administration of the

Properties of Chenopodium Not Fully Understood. It seems, however, that there are on the market a number of varieties of chenopodium which differ greatly in strength and toxicity. The variations in different samples are especially noticeable in the chemical composition of the oil, and are exhibited in its appearance, taste, smell, specific gravity, and volatility. During 1919, there was marketed a supply of the oil which proved highly toxic in effect and which caused several fatalities. More than half of these deaths occurred after second or even third

oil in the field, and that the dosage for children should be made smaller than is indicated by Young's rule.

Experiments in Distilling and Testing Chenopodium. With a view to arriving at a better pharmacopeial standard for the preparation of oil of chenopodium, Hall and Hamilton made a study of the composition of the drug and the anthelmintic value of some of its components. They report that their tests of the distillation products of the oil indicate that the greatest anthelmintic efficacy resides in the lightest fraction of the drug. As the heavier fractions are used the efficacy shows diminution. Moreover, the heavier fractions cause marked gastro-intestinal irritation, and in dosage equivalent to the standard therapeutic dose of the oil, produce hemorrhagic conditions of the stomach and intestines even in the presence of castor oil, which is highly protective. Hall and Hamilton believe that the value and safety of oil of chenopodium would be greatly increased if the ordinary marketed product were re-distilled at a temperature up to 125° C. (257 F.) with a pressure equal to 30mm. of mercury. This process would eliminate that fraction of the drug which has less anthelmintic value and more irritant and toxic qualities than the lighter fraction.

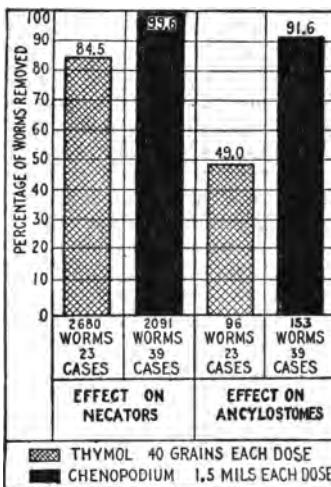


Fig. 43.—Comparative efficacy of thymol and oil of chenopodium in half-maximum doses. Based on experiments with sixty-two cases in studies by Uncinariasis Commission to the Orient

STANDARD TECHNIQUE OF THYMOL ADMINISTRATION

The routine dosage of thymol recommended by Stiles, Dock Howard, Bass, and others of wide experience in the treatment of hookworm disease, is the one most commonly employed in the countries where thymol is used. It is based upon 60 grains as the maximum for an adult, preceded and followed by an active saline purgative. Children from one to five years of age receive from 3 to 5 grains of the thymol; those from six to ten, from 10 to 15 grains; and those from eleven to fifteen, from 15 to 30 grains. Persons between sixteen and twenty years of age receive from 30 to 40 grains; those between twenty-one and fifty years, from 45 to 60 grains;

and those more than fifty years, from 30 to 45 grains. The drug is usually administered in finely powdered form, mixed with equal parts of milk sugar or sodium bicarbonate. It is given in two equally divided portions, and apparent (not actual) age determines the dosage. Competent physicians examine all patients who are to take the drug, prescribe the proper dosage for each, and supervise the important phases of the treatment.

Conditions Governing Administration of Thymol. Food is not allowed from the time of the first purgative until after the final dose of salts has acted. Inasmuch as alcohol and oils, and gravy, butter, milk, or other fatty foods, are especially dangerous, the patient is cautioned against taking them at any time during the period of treatment. Under field conditions it is generally held that thymol should not be administered to persons suffering from acute diseases such as malaria in the febrile stage or fevers of any other type; those having chronic dysentery or diarrhea, organic cardiac or renal disease, pulmonary tuberculosis beyond the incipient stage, or general anasarca; those who are extremely weak or feeble from old age or from other cause; and pregnant women, or women with serious hemorrhagic diseases of the uterus. Thymol may be administered to persons suffering from any of these diseases only when the circumstances will permit rigid control of all features connected with the treatment.

• USE OF CHENOPODIUM AS AN ANTHELMINTIC

Oil of chenopodium is now used more extensively than thymol in all countries with which the Board co-operates, except Jamaica, British Guiana, Trinidad, and Saint Lucia. Its comparatively low cost and the relative scarcity of thymol brought about by the World War have doubtless been factors in some measure leading to its wide-spread use. Following the reduction in dosage recommended by the Board's Uncinariasis Commission to the Orient, the drug was employed in administering 437,166 treatments to 191,377 persons during 1918, and gave exceptionally favorable results. In 1919, however, a few fatalities and a noticeable increase in the number of cases of Chenopodium poisoning were reported as a result of the administration of 466,456 treatments of the oil to 192,177 persons. The untoward effects which attended the use of the drug during 1919 led to the studies above described, from which it is hoped to learn full particulars as to the pharmaceutical properties of the oil.

Standard Method of Administering Chenopodium. The standard method of administering chenopodium as used by the Board during 1919 was that recommended by Darling, Barber, and Hacker as a result of their experiences with various vermicidal drugs in the Orient and published in their article entitled "The Treatment of Hookworm Infection."¹ It consists of an adult dose of 1½ mils

¹ The Journal of the American Medical Association, February 23, 1918, vol. 70 pp. 449-507.

divided into three equal parts and administered as follows: the first portion at 7:00 a. m., the second at 8:00 a. m., and the third at 9:00 a. m. A light evening meal followed by a purgative dose of magnesium sulphate is usually given on the evening preceding treatment, and a very light breakfast, consisting of milk or thin rice gruel, on the morning of treatment. Two hours after the last portion of chenopodium is taken, a second purgative dose of magnesium sulphate is administered. Effective post-treatment purgation is thought to be essential to eliminate the dead or stunned worms and the unabsorbed oil. A second post-treatment purgative may be given if the first fails to act freely and promptly. Later researches by Mhasker and Caius, however, make it seem doubtful whether effective post-treatment purgation is really required.

Schedule of Chenopodium Dosage for Children and Adults. The directors of the work in Ceylon, who have made extensive use of the drug in small doses, have worked out a dosage table for children and adults. Children who *appear* to be between the ages of two and twelve years receive 1 minim for each year of age, minus 1 minim.² This means that a child of seven receives 6 minims, a child of six 5 minims, and so on. Persons from thirteen to fourteen years of age receive 13 minims; those from fifteen to sixteen, 16 minims; from seventeen to eighteen, 20 minims; and from nineteen to twenty, 24 minims. It will be noted that especially small doses are administered to children under twelve. The oil is dropped from a dropping-bottle into simple sugar syrup. In Ceylon this syrup has proved the most satisfactory of all the vehicles in which the oil has been administered. The directors of the work in this country also report that in addition to the contra-indications to thymol treatment mentioned on page 92, the use of chenopodium is contra-indicated when the patient has peptic ulcers or gonorrhea.

Efficiency of Standard Chenopodium Treatment. The director and the assistant director of the Department of Hygiene at the University of São Paulo, assisted by the staff engaged in hookworm control measures in Brazil, have made considerable progress toward establishing the probable average efficiency of the foregoing dosage under field conditions. In the original experiments, made in the Orient under laboratory conditions, two standard chenopodium treatments, separated by an interval of ten days, removed 99 per cent of all the hookworms harbored by a group of thirty-nine adults. One hundred fifty-six cases were similarly treated in Brazil during 1918, except that the work was done largely under field conditions, and 97 per cent of the worms they harbored were removed. Thus the Brazilian experiments confirmed, in so far as the smallness of

² Special attention is directed to the fact that a minim by weight equals approximately two drops by measure.

the numbers involved may be accepted as confirming, the tests made in the Orient. A large amount of additional field experience will need to be gained, however, before the entire practicability and efficiency of the routine treatment may be regarded as definitely established. Among the factors remaining for further investigation is the apparent difference in power of resisting treatment between the *Ancylostoma duodenale* and the *Necator americanus*, and between persons who harbor large numbers of worms and those who harbor only a few.

a. Experiments with standard technique among Brazilian vagabonds. Eighty-two vagabonds more than fourteen years of age, who lived at an institution in Pinheiro, in the state of Rio de Janeiro,

were treated three times with chenopodium. The first two treatments consisted of $1\frac{1}{2}$ mils each and the third of 3 mils.* These treatments expelled a total of 10,895 worms. Fig. 44 shows the efficiency of each treatment as based on two factors: the percentage of worms expelled, and the percentage of cases cured. In this group there were only nine relative failures of the treatment, or cases which harbored ten or more worms after two $1\frac{1}{2}$ mil treatments had been taken. The conditions of this experiment, however, permitted a rigid control of the patients and approached the exactness of a laboratory test. The results, therefore, cannot be accepted as altogether representative of those to be expected when the remedy is administered in the field.

b. Tests on heavily infected

farm and in lightly infected village. Two trials were made in Atibaia, Brazil, to determine the efficacy of the standard treatment as administered under field conditions by regular campaign dispensers. In the first test, two localities were chosen: a severely infected farm, and a mildly infected village. Ten persons in each locality were selected for treatment. Each received two routine treatments

* The third treatment (consisting of 3 mils) is not, of course, a part of the routine chenopodium administration. It was given to insure the quick recovery of all the hookworms harbored. Under ordinary conditions a dose of this size is not without its dangers.

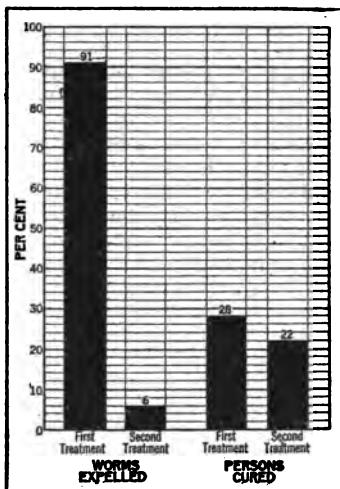


Fig. 44.—Worms expelled and cases cured by two treatments of chenopodium. Eighty-two Brazilian vagabonds

of chenopodium from the dispensers. Two weeks after they had taken the last of these two treatments, they were given a large 3-mil test dose of chenopodium. In the farm group there still remained 134 worms, or thirteen per case, after the first two $1\frac{1}{2}$ mil treatments had acted; in the city group, seven or .7 per case. There were 50 per cent of relative failures among the farm residents. The number of worms harbored by this group before treatment was undoubtedly high, however, as two controls on the same farm who, before receiving the 3-mil dose, had been treated only once with $1\frac{1}{2}$ -mils, expelled after the second treatment an average of 148 worms apiece. The results of this test would seem to show that in heavily infected districts where the average worm count is 200 or more, or where the hemoglobin of non-malarious individuals is below 60, two routine treatments of $1\frac{1}{2}$ mils each are not always sufficient and a third treatment is advisable.

c. Experiments on typical coffee farm. In the third experiment fifty-six persons living on a large, typical coffee plantation in the state of São Paulo, Brazil, who had already been treated twice in the routine way by campaign dispensers, were given, twelve days later, a single large dose of chenopodium. These cases were found to harbor, on the average, 5.8 worms per case after they had taken the first two treatments, while four control cases treated for the first time averaged 176 worms per case. In 41 per cent of the cases every worm was expelled by the first two treatments; in 21 per cent there was relative failure of the drug.

Interval between Treatment with Chenopodium and Re-Examination. Chenopodium has a distinctly inhibitory effect upon the egg-bearing functions of the female hookworm. If the drug fails to kill the worms, however, this effect is only temporary, and after an interval the females resume the laying of eggs. A series of test cases conducted during 1918 by a special nurse in the city hospital of São Paulo, showed that after administration of chenopodium treatment the ova disappeared from the feces and, if the cases were not cured, re-appeared the eighth to thirteenth day. This confirmed the findings of earlier investigators. Most of those who have studied the subject agree that re-examination should be made in not less than fourteen days after the vermicide has been taken. This is the period customarily allowed in the countries where chenopodium is used.

Relative Efficacy of Chenopodium Administered in Manufactured As Compared With Freshly Filled Gelatine Capsules. The superior efficacy of freshly prepared hard gelatine capsules of chenopodium, as compared with the manufactured soft capsules which have thick, tough gelatine walls, was demonstrated by a series of test treatments conducted by the Uncinariasis Commission to the

Orient. One group of patients received manufactured chenopodium capsules in three doses of .5 mils each, at hourly intervals, with the result that only 66.4 per cent of the worms present were expelled. A second group, treated with chenopodium which had been extracted from the manufactured capsules and placed in freshly prepared capsules, also received three doses of .5 mils each. By the latter treatment 97.9 per cent of the worms harbored were expelled (Fig. 45.)

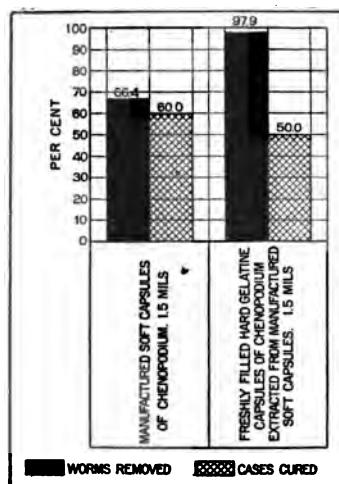
Effect of Diet on Efficiency of Chenopodium. As a rule,

authorities advise a very light diet during the twenty-four hours preceding the administration of chenopodium. Field experiments conducted during 1919 by the Department of Hygiene of the University of São Paulo, however, showed that when patients were allowed their usual diet on the day before treatment, but no food on the morning of treatment, by far the best results were obtained from the vermicide. When this procedure was followed and a preliminary purge given, 87 per cent of the worms harbored were expelled by one treatment (1.5 mils); with preliminary catharsis omitted, 93.3 per cent of the worms present were expelled. When patients were allowed no solid food after 11 a. m. on the day before treatment and no nourishment of any kind after 5 p. m., and when the preliminary purge was omitted, only 75.5 per cent of all worms were

Fig. 45.—Efficacy of manufactured capsules compared with that of freshly-filled capsules as medium for administering chenopodium. Based on experiments with fourteen cases in Federated Malay States

removed by one standard treatment. Moreover, prostration was universal among patients receiving this diet, and their toxic symptoms were more severe than those manifested by any other group of patients.

In other areas of operation, also, experience has shown that a light diet on the afternoon preceding treatment is not advisable, especially in the case of persons of poor physique. In Ceylon, where the average laborer is greatly undernourished, it was found that coolies who ate an ordinary meal on the afternoon before treatment were much less apt to suffer collapse or syncope after medication than



those who were limited to an afternoon meal of rice gruel. The percentage of cures was as high among patients whose afternoon meal was not restricted as among those who ate a light repast. In the Seychelles Islands, too, it was found that there was no diminution in the percentage of cures when a regular diet was permitted on the day preceding treatment. Moreover, patients were far more willing to take treatment when their diet was not restricted on the previous day.

Magnesium Sulphate the Most Satisfactory Purge for Use with Oil of Chenopodium. Although none of the purgatives which have been employed in connection with chenopodium have given entire satisfaction, magnesium sulphate has been reported upon more favorably than any of the others which have been tried. The rapidity of action of this purgative has been found to vary in inverse proportion to its concentration. Experience in Ceylon has shown that when a strong solution is administered, catharsis is often delayed until evening of the day of treatment, or even until the next morning. A weaker solution (2 pounds of salt to a gallon of water, or about $1\frac{1}{2}$ drams to the ounce) gives much prompter action and is less apt to cause griping or collapse. The most satisfactory dosage of magnesium sulphate appears to be $2\frac{1}{2}$ ounces for adult males and 2 ounces for adult females.

Omission of Preliminary Purge with Oil of Chenopodium. Most authorities hold that better results are obtained if the pre-treatment purgative is given; and in hospital practice, where the patient can rest and be under constant observation, it seems best to give it. But when it is given in field work, many of the patients, after it has acted, become weak and in some instances are unfit for work next day, with the result that they lodge complaints against the treatment. Moreover, in sparsely settled rural areas the administration of a preliminary purge is a difficult procedure and almost doubles the cost of treatment. The original experiments of Darling, Barber, and Hacker, although dealing with a number of cases too small to enable trustworthy conclusions to be drawn from them, nevertheless showed that when this purge was omitted and the other factors were kept the same as in routine treatment, two standard doses of $1\frac{1}{2}$ mils of chenopodium cured 80 per cent of the cases and removed 95 per cent of the total worms. This suggested that with an interval of twelve hours between eating and the administration of the vermifuge, the preliminary purge might be omitted.

In a series of experiments conducted in Brazil during 1919 it was found that when a preliminary purge was administered, one trial treatment consisting of $1\frac{1}{2}$ mils of oil of chenopodium given in two equal doses cured 29 per cent of the cases treated and removed 75 per cent of the total hookworms harbored. When the preliminary purge was omitted only 14 per cent of the cases treated were cured,

but 83 per cent of all hookworms were removed. The percentage of failures—cases with ten or more hookworms remaining after trial treatment—was 40.6 per cent in the case of persons receiving a preliminary purge, as compared with only 31 per cent for persons in whose treatment the preliminary purge was omitted. Thus, by all standards except that of the percentage of persons cured, the results were better when preliminary catharsis was omitted.

In a second group of experiments, in which the patients were treated with 2 mils of oil of chenopodium administered in a single dose and followed in two hours by a saline purge, it was found that in the case of those who had received a preliminary purge 12 per cent were cured by the trial treatment, 93.8 per cent of all hookworms were removed, and there were 36 per cent of failures. When the preliminary purge was omitted none of the patients treated were cured, only 87.5 per cent of all worms were removed, and there were 63.3 per cent of failures. From these findings it would seem that when the drug remains in the intestines only two hours, as is the case when it is administered in an undivided dose, a preliminary purge is necessary to aid in hookworm elimination, but when the drug is administered in divided dosage and at least a portion of it remains in the intestines for four hours, a sufficient time elapses for the drug to produce its effect, whether or not the intestines have been prepared by preliminary purgation.

In field treatments given during 1919 in Guatemala, Brazil, Ceylon, and the Seychelles Islands, preliminary purgation was omitted. No ill effects resulted in any of these areas, and there was no decrease in the percentage of cures as compared with that in other years.

Effect of Purgative on Efficiency of Remedy. Tests made in China during 1918 suggest that the rôle played by the purgative in removing the worms from the intestines, is an extremely important phase of treatment which has perhaps not been sufficiently investigated. It was noticed that the percentage of living worms expelled was increased if the salts acted quickly. This meant either that longer contact with chenopodium kills a larger percentage of worms, or that in many cases the drug temporarily loosens the hold of the worm on the intestinal wall so that a strong purgative will expel many living worms. A series of observations was then made to ascertain what effect an increase in the dose of magnesium sulphate had on the percentage of cures.

Increased Efficiency of Chenopodium with Free Purgation. The amount of chenopodium used was an undivided dose of 2 mils. At first 25 mils (1 ounce) of magnesium sulphate was administered the evening before treatment, and 50 mils two hours after the chenopodium had been taken. Of 395 infected persons treated by this method, 286, or 72.4 per cent, were found negative after one treatment. The results were so good that the amount of salts was increased to 50 mils instead of 25 on the evening before treatment,

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and to 141 mils (4½ ounces) instead of fifty after the taking of the chenopodium. The salts given after the vermifuge were divided into two portions, one-half being administered at the end of two hours and the other half at the end of four. Of 620 persons treated in this way, 499, or 80.5 per cent, were found negative after one treatment. With the increase in the amount of salts given, there was not one case which showed any symptoms of chenopodium absorption. There were nausea and vomiting at times, but there were no ill effects due to the action of chenopodium.

CHENOPODIUM-CROTON OIL TREATMENT AS DEVELOPED IN CEYLON

In Ceylon during 1918 there was developed a special form of treatment which was used extensively during that year and in the early part of 1919. According to this treatment the preliminary purge was omitted, and a mixture of chenopodium 40 parts and croton oil 1 part was given in the standard dosage prescribed for chenopodium (see page 93), graduated according to the apparent and not the stated age of each person. The dose was usually given in two equal parts with an interval of one hour between. Two hours after the last dose of vermicide the patient received a purgative dose of magnesium sulphate.

Conditions Governing Chenopodium-Croton Oil Treatment. All patients were kept under observation by the dispenser from the time of giving the first portion of the vermicide until the medical officer in charge was satisfied that the post-treatment purgative had acted freely. Meanwhile, the patients were allowed to rest in a sheltered place. Temporary sheltered latrines for men and women were provided near the resting place, and an apothecary or dispenser saw that the latrines were properly used. Before the patients were discharged, they were strongly counseled not to eat raw fruit or vegetables for a day or two after treatment, but to take chiefly rice and rice gruel.

Discontinuance of Chenopodium-Croton Oil Treatment in Ceylon. The chenopodium-croton oil treatment was found to have many advantages. Some of its best features were that smaller doses of salts were required to secure effective post-treatment purgation, that such after-effects as exhaustion, rheumatoid pains, and tinnitus were much less in evidence, and that in almost all cases the patients were able to work the following day. In the early part of 1919, however, a small percentage of cases treated with the chenopodium-croton oil mixture developed enteritis. In some patients dysenteric symptoms developed which required prolonged treatment. These untoward symptoms created a prejudice against the mixed treatment

which was difficult to allay, and in May it was decided to discontinue its use temporarily, substituting for it the plain chenopodium treatment.

CHENOPODIUM-CHLOROFORM TREATMENT EMPLOYED IN NICARAGUA

During 1919 a mixed treatment of chenopodium 3 parts and chloroform 1 part, by volume, was used in Nicaragua with considerable success. The mixture was given in rather large doses—3 mils the maximum adult dose—so the percentage of cures effected by two treatments was very high, much greater than with chenopodium alone. Patients treated according to this technique reported no unpleasant after-effects.

ADMINISTRATION OF CHENOPODIUM IN UNDIVIDED DOSES

In an experiment conducted by the Uncinariasis Commission to the Orient, 2 mils of chenopodium administered in two equally divided doses removed 96.2 per cent of the worms harbored by eight cases, while the same amount of the drug administered in a single massive dose expelled 95.8 per cent of the worms in twenty-five other cases. Experiments conducted by the Department of Hygiene of the University of São Paulo showed that an undivided dose of 2 mils of chenopodium, preceded by a purge, removed 93.8 per cent of all worms, whereas 1½ mils of the drug administered in three equal doses expelled only 90.8 per cent of the worms harbored, and 1½ mils administered in two equal doses expelled only 75 per cent of all worms. These figures suggest that it is probably unnecessary to divide the dose. Experiments to determine this point have also been made by the directors of the work in several countries.

Experience in Seychelles Islands and in Ceylon. The medical officer in charge of the work in the Seychelles Islands administered to a limited number of cases the full daily dose of chenopodium at 6:00 a. m., without preliminary purgation, but the results obtained were not so good as when the regular routine of chenopodium treatment was followed. In Ceylon, similarly, the entire amount of chenopodium in one dose was administered experimentally on a number of estates. The method is still under trial, but the directors report that it does not appear suitable for use in the presence of heavy infection.

Experience in China. The director in China, on the other hand, made extensive use of a single 2-mil dose, and in a group of experimental cases obtained satisfactory results, the percentage of cures

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after one treatment being approximately 87.0. The experience in that country indicates that chenopodium in this dosage is seldom contra-indicated. Persons with active tuberculosis, moderate heart lesions, and acute bronchitis were treated and showed no ill-effects. It should be pointed out, however, that all the patients dealt with were male adults between eighteen and fifty years of age, and that the doses of salts used were larger than are customarily administered in other countries.

USE OF CHENOPODIUM IN TREATMENT OF AMEBIC DYSENTERY

In a number of countries oil of chenopodium is now being employed in the treatment of dysentery. It is reported to remove encysted ameba, to cause the disappearance of blood and mucus from the feces, and to give prompt relief to the patient.

Routine Chenopodium Treatment for Relief of Dysentery. In Siam the treatment used is as follows: 37 mils (1½ ounces) of magnesium sulphate are first given. Two hours later 1 mil of oil of chenopodium follows. One hour later a similar dose of the oil is administered, followed in another hour by 37 mils (1½ ounces) of castor oil. For more severe cases, either the preliminary purgative is omitted and 2 mils of chenopodium in 37 mils of castor oil are given in a single dose, or 1 mil of oil of chenopodium, emulsified with gum acacia, is administered by way of the rectum. In the latter mode of treatment the anal mucosa is protected by petrolatum and the injections are terminated with 50 mils (2 ounces) of an inert oil. The buttocks are elevated, and the enema—the first dose of which does not exceed 200 mils (8 ounces) for an adult—is given slowly.

EFFICACY OF BETA-NAPHTHOL IN THE TREAT- MENT OF HOOKWORM DISEASE

For several years beta-naphthol has been used to some extent in the treatment of hookworm disease. But as yet the anthelmintic efficiency and the toxic qualities of the drug have not been definitely established. Experience seems to show, however, that small doses of the drug—.5 to 1.0 grams—while very slightly toxic, have low anthelmintic power. Darling, Barber, and Hacker found that a single treatment with 40 grains of beta-naphthol removed only 26.7 per cent of the hookworms present; and Hackett in a series of experiments which included 1,114 cases discovered that two doses of the drug, each consisting of 4.5 grams, cured but 22 per cent of the cases treated.

Use of Beta-naphthol in Large Doses. Recently several studies have been made to determine the effect of beta-naphthol in larger doses. Bayma and Alves, in a series of hospital experiments in

Brazil, treated a number of cases with 18 grams of this vermicide. The cases received a preliminary purge on the evening before treatment, and on the following day they were given 6 grams of beta-naphthol in six divided doses administered at fifteen-minute intervals. This treatment was administered on three successive days until the total dose of 18 grams had been given. A saline purge was administered on the final day of treatment, two hours after the last capsule of beta-naphthol had been taken. The treatment resulted in the cure of 85 per cent of the patients treated. Apparently no ill effects followed the large dosage.

Gonzaga and Lima slightly modified the Bayma-Alves treatment in order to make it more practical for field work on a large scale. According to their method, the preliminary purge was omitted and 6 grams of beta-naphthol were administered in one dose early in the morning. The dosage was repeated for three successive days, and a saline purge was given two hours after the last dose of the drug. Throughout the treatment patients were placed on a light diet. Of 400 severely infected cases treated by this method during 1918, as many as 73.5 per cent were reported cured.

Toxic Effect of Large Doses of Beta-naphthol. Although in the experiences of Bayma and Alves and of Gonzaga and Lima, 18-gram doses of beta-naphthol proved practically non-toxic, Smillie conducted further experiments in Brazil, during 1919, which showed that under certain conditions beta-naphthol in large doses may produce severe toxic symptoms. In the case of four patients who received 18 grams of the vermicide, red blood cells were destroyed in great numbers, with resultant severe anemia, icterus, hemoglobinuria, and enlargement of the spleen, liver, and gall bladder. The white blood cells apparently were not destroyed by the drug. The liver, spleen, kidneys, and other organs of the body were not affected primarily, but were markedly affected secondarily, because of the anemia and the injurious effects produced by the elimination of large numbers of destroyed red blood cells. The type of case most susceptible to beta-naphthol poisoning has not been determined. In three of the severe cases of poisoning, however, there was a history of recent malaria. It may be that persons whose red blood cells have been rendered fragile by recent attacks of malaria, are more sensitive than others to the toxic action of the drug.

INTRA-INTESTINAL TUBE TREATMENT OF HOOKWORM DISEASE

A new method of treating hookworm disease, known as the intra-intestinal tube method, was devised during 1918 by Kantor, who used it with excellent results in the treatment of over 250 cases in the United States Army Hospital at Fort Oglethorpe.

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This technique is based on the theory that since science has established the exact habitat of the hookworm within the human host—namely, the first portion of the jejunum, with extension along the intestine in both directions in the more severe infections—the parasites can be removed most expeditiously by a method which permits the introduction of a concentrated dose of vermicide at the exact site of infection. The tube treatment secures this concentration, whereas when the drug is taken in capsule form, a considerable portion may be lost either by the dissolution of the capsule below the site of infection, or through the dilution of the drug by secretions if the capsules dissolve above the area of infection. Moreover, when the tube is employed the drug can be delivered in one dose, its work can be accomplished quickly, and its elimination can be promptly secured. These factors lessen the danger of cumulative toxic absorption.

Description of Intra-Intestinal Tube Technique. When this technique is employed the patient is given a light meal—chiefly rice and milk—on the evening before treatment. There is no preliminary catharsis. The next morning at about 7:30 the duodenal tube is swallowed on a fasting stomach and the patient is kept on his right side until the bucket has passed the pylorus.⁴ The exact time at which the bucket enters the intestine can be determined by aspiration. While it is in the stomach, aspiration withdraws a clear fluid, seldom bile-tinged, and generally positive to Congo paper; and if water is injected into the tube, followed by a syringeful of air to clear the tube, the greater part of the water can be withdrawn by aspiration. When the bucket has entered the duodenum, aspiration withdraws golden-yellow viscid bile, negative to Congo paper. The water injected flows on into the intestines and only a small amount can be recovered.

As soon as the bucket reaches the duodenum the patient is ready to receive the drug. This is injected with a syringe (preferably of glass, and of about 30 mils capacity) and is followed by a barrel or two of air to insure the expulsion of the entire dose from the tube. The dosage of vermicide usually employed is 3 mils of oil of chenopodium. Following the injection, a period of six minutes is allowed for the diffusion of the oil throughout the worm-infested region. At the expiration of this time 2 to 3 ounces of a warmed saturated solution of magnesium sulphate are given transduodenally to remove the drug quickly from the very highly absorptive small intestine. Within half an hour the majority of patients have a copious watery stool containing oil and sometimes worms. This flush method of controlling the drug permits its use in doses ordinarily considered dangerous.

⁴ With the buckets (Einhorn, Rehfuss) used by Kantor, this usually took place within three hours. The tube used by Jutte is said to pass the pylorus more quickly.

After the salts are given, the tube is removed and the treatment is complete. In most cases from three to five stools follow the first. If a sufficient number do not result, further catharsis may be administered by mouth. The patient is generally sick during the day of treatment, but by 5:00 p. m. he is ready for a light meal, and usually he has made a complete recovery by the next morning.

MANNER OF DETERMINING RELATIVE EFFICIENCY OF DRUGS

The proportion of infected persons cured by two treatments does not always convey an adequate idea of how efficient a remedy is. Two treatments of a powerful vermicide may remove from a large

CASE NO	WORMS HARBORED	WORMS REMOVED BY TWO TREATMENTS	PERCENTAGE OF WORMS REMOVED BY TWO TREATMENTS
1	64	48	75.0
2	195	193	99.0
3	873	461	52.8
4	1227	498	73.2
5	439	439	100.0
6	93	27	29.0
7	291	120	41.2
8	686	678	98.8
TOTAL	3868	2864	74.0
Percentage of Worms Removed from Group			$\frac{2864}{3868} = 74.0$
Average Percentage of Worms Removed from Each Individual*			$\frac{569.0}{8} = 71.1$
Knowlton's Index of Efficiency			$\frac{74.0 + 71.1}{2} = 72.6$

* Addition of Figures in columns headed Percentage of Worms Removed by Two Treatments, divided by the number of cases treated.

Fig. 46.—Method of computing Knowlton's index of efficiency

proportion of cases all but 2 or 3 per cent of the worms they harbor, and still fail to effect the complete cure of any considerable number of the patients. Thus, in a series of experimental cases, two treatments of chenopodium, each consisting of $1\frac{1}{2}$ mils, have expelled more than 95 per cent of the hookworms harbored and yet cured only from 40 to 50 per cent of the cases. To effect the complete cure of all infected persons required, on the average, four treatments of the drug. This meant that the additional two treatments were used to expel less than 5 per cent of the worms originally harbored.

Efficiency As Estimated by Percentage of Worms Removed.
For judging the efficacy of a drug the percentage of worms expelled is a better criterion than the percentage of cures obtained. It affords

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a satisfactory measure of efficiency in districts where there is moderate or severe infection distributed with a fair degree of uniformity among various classes of the population. But where the infection is mild and there are a few carriers with a disproportionately large number of worms to dominate the results, its value is not so great. One of the chief advantages of the worm-count method lies in the fact that the worm-count is a positive finding, all errors tending to decrease the apparent efficiency of the drug; while in estimating efficiency by cures all errors of omission, due to faults inherent in the methods of diagnosis followed, tend to enhance the apparent value of the remedy by fictitiously increasing the number of cases registered as cured.

Knowlton's Method of Determining Efficiency. By adding the percentages of worms removed from each member of a group of infected individuals, and dividing the total of these percentages by the number of individuals comprising the group, a fairly good index can be obtained. This method is open to the objection, however, that the case with one worm will count for as much as the one with a thousand. Knowlton therefore recommends combining this method with the one whereby efficiency is determined on the basis of the percentage of worms removed from the group. The two percentage figures thus derived are averaged, and a figure is obtained that is believed to give the most satisfactory index of efficiency of any method yet evolved. Figure 46, page 104, illustrates this method of obtaining the efficiency index, as applied to a supposititious group of eight cases.

V

HOOKWORM INFECTION SURVEYS

The Board's participation in measures against hookworm disease in any state or country is contingent upon official invitation from Government. As a preliminary step to the arrangement of a definite program, it is customary to make an infection survey of the territory. This survey defines the geographical prevalence and distribution of the disease and the practicability of its control, makes available data concerning the insanitary conditions which are responsible for the presence and spread of the infection, and furnishes information relative to the public health or other agencies through which systematic efforts against the disease can be begun with greatest promise of success. Thus the survey gives to Government and to the Board definite information upon which a satisfactory working agreement can be based. This information is also of much assistance when the measures designed to reduce the incidence and severity of the disease are put into operation.

Infection Surveys Conducted or Authorized. During 1919, infection surveys were undertaken and completed in the states of Paraná and Minas Geraes, Brazil; and other surveys were begun, but not completed by the end of the year, in the states of Maranhao, Santa Catharina, and Bahia, Brazil; in Porto Rico; and in Colombia, South America. Surveys were authorized, but not begun during the year, in Mauritius, Borneo, and the presidency of Madras, in India. At the completion of the surveys of Paraná and Minas Geraes, these states entered upon co-operative programs for the control of hookworm disease.

INFECTION SURVEY OF PARANÁ

An infection survey of the state of Paraná, Brazil, was made between August 4 and October 31, 1919. Approximately 1 per cent of the population of the state was examined in ten different survey centers, which were chosen as representing the three typical divisions of the state—the agricultural lowlands, the somewhat higher but heavily wooded and well-watered timberlands, and the cool, cattle-raising uplands. Groups examined were representative of urban and rural populations, of various occupations, of all age and social groups, and of all types of physical condition.

Rate of Hookworm Infection in Paraná. The average rate of infection for the entire state was found to be 31.9 per cent. In the lowlands the rate reached 77.5 per cent; in the higher forest region it was only 25.6; and in the prairie uplands it was 11.1. Of the rural

population examined 45.6 per cent were infected, as compared with 25.9 per cent among town and city inhabitants. A summary of the occupational incidence of infection showed the highest rate—41.2 per cent—among agricultural laborers. Factory workers came next with an infection rate of 35.8. As is usually the case, the conditions surrounding wealth and education gave relative protection against infection, but that the protection afforded was not absolute is evidenced by the infection rate of 13.6 per cent which obtained among professional men and estate proprietors. About half of the persons examined claimed to use latrines. The infection rate obtaining among these persons was 22.1 per cent, as against 39.1 per cent among those who had no latrine accommodations.

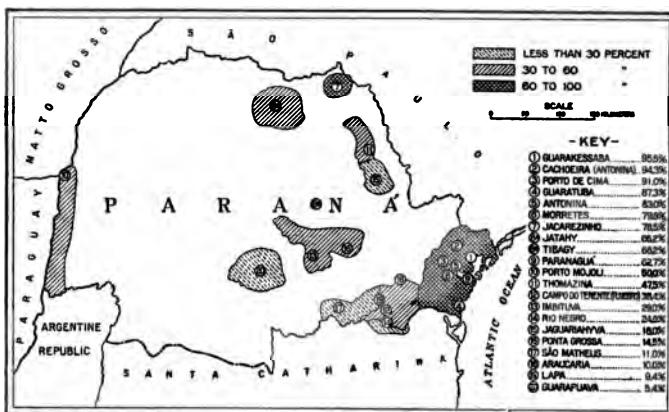


Fig. 47.—Hookworm infection map, state of Paraná, Brazil

Severity of Hookworm Infection in Paraná. Hemoglobin tests of over 4,000 persons showed the relative gravity of the infection in this state. Persons infected with hookworm disease and giving evidence or history of malaria, had a hemoglobin average of 65.5 per cent, while those having hookworm infection but giving no evidence or history of malaria showed a hemoglobin average of 67.8 per cent. Although the incidence of hookworm infection in the state of Paraná as a whole is light in comparison with that in other Brazilian states, it nevertheless constitutes a most serious drain on the health and working capacity of a large number of inhabitants.

SURVEY FINDINGS IN MINAS GERAES

On June 29, 1919, an infection survey was undertaken in the state of Minas Geraes, Brazil. Examinations were made in twenty communities selected as representative centers of the two main divisions

of the state—the prairie region, where the soil is sandy; and the fertile wooded region, with its subsoil of clay loam. In all, 8,499 persons were examined. Of these, 72.3 per cent were found to be infected with hookworm disease. The average rate of infection in the prairie section was 66 per cent, as compared with 90 per cent in the fertile wooded area. Hemoglobin averages, which varied from 73.8 in the region of lightest infection to 57.3 in the most heavily infected area, indicated that the degree of infection prevailing throughout the state was relatively high. Latrines are little used except in certain of the more progressive cities. Of the 8,499 persons examined, only 637 stated that they used latrines. The greater number of the persons who used latrines lived in suburbs of the cities, where there are more

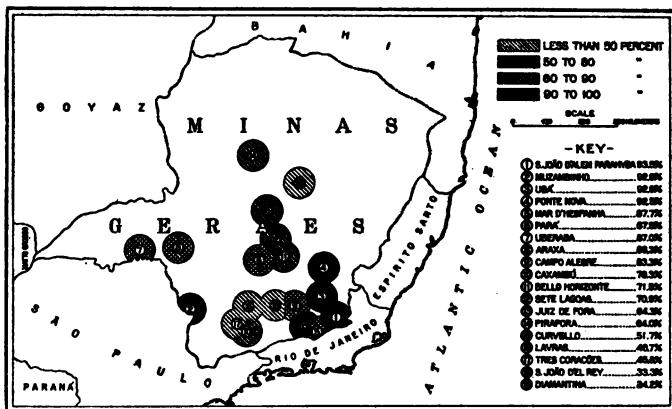


Fig. 48.—Distribution of hookworm disease in state of Minas Geraes, Brazil

or less complete sewerage systems. The people proved very amenable to suggestions regarding sanitary improvements, and a systematic educational campaign should be productive of wide-spread reform.

PREVALENCE OF HOOKWORM INFECTION IN PORTO RICO

As early as 1904, measures to control hookworm disease were inaugurated in Porto Rico by Ashford, King, and Guiteras; from that time on, the work has been continued with more or less regularity. Most of this work was of the dispensary type. Extensive measures for the control of soil pollution were not carried into effect. At the end of fifteen years the infection rate on the island remains well over 80 per cent. In the rural districts of the island fully three-

fourths of the homes are without latrine accommodations. Of the existing latrines, not one in one hundred is sanitary. Considerable soil pollution exists even in towns that have sewerage systems. Late in 1919 the Health Commissioner of the island invited the International Health Board to send a representative to Porto Rico for the purpose of ascertaining the present rate of hookworm infection. In response to this request an infection survey was inaugurated toward the close of the year.

Findings of the Porto Rico Survey. Ten representative areas were chosen for survey work, and 2,000 examinations were set as a sufficient number to give a fair index of the prevailing rate of infection. Each district was allotted a share of these examinations proportionate to the total number of its inhabitants. In consequence, examinations were representative of all types of the population. Results of microscopic examinations showed that except in urban centers, the incidence of hookworm infection was extremely high. The average rate of infection in the ten areas was 82.6 per cent. In certain coffee and sugar districts the percentage of infection reached 100. As determined by hemoglobin index and worm counts, infection was found to be not only high but severe. The hemoglobin average among infected persons was only 64.1 per cent. The co-operation of Government and of the people throughout the survey was all that could have been desired. There is every prospect that an energetic control program, which stresses latrine building and other proper preventive precautions, will produce excellent results in bringing about a reduction in the prevalence of the disease.

INFECTION SURVEY BASED ON WORM COUNTS

A new type of infection survey, with worm counts as its central feature, was developed by the Board's Uncinariasis Commission to the Orient. This method was employed in carrying out the survey of Java in 1916 and has since come into extensive use in Brazil. The customary microscopic examination of fecal specimens is dispensed with, and the counting of worms expelled as the result of treatment by representative groups of persons is substituted.

Methods of Conducting Worm-Count Survey. The patients to be treated are carefully selected from the different localities to be included in the survey. Effort is made at all times to secure groups whose state of health closely approximates the average for their communities. Not less than twenty-five nor more than thirty persons are usually chosen for each locality, adults comprising two-thirds of the group. Different activities and occupations find proportionate representation, and the number of males and females—of boys and girls as well as of men and women—is equalized wherever possible. The persons to be examined are treated with a vermifuge, and all stools which they pass for three days are retained, washed,

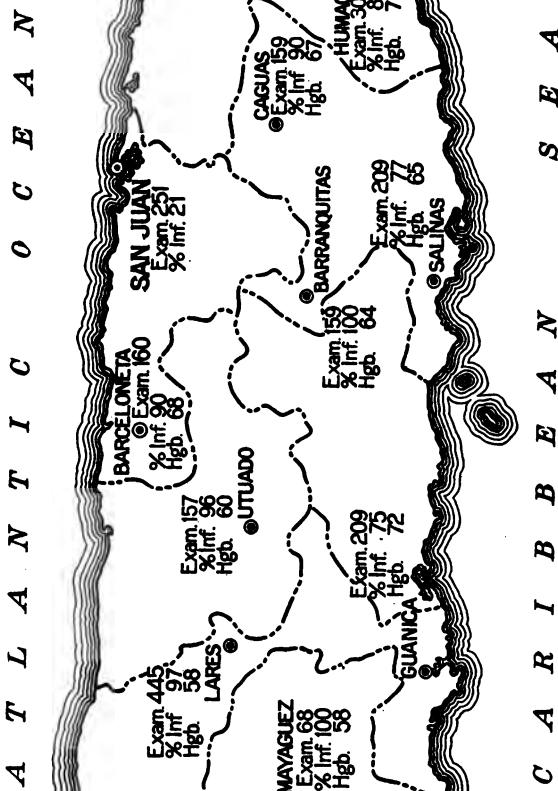


Fig. 49—Hookworm infection survey map of Porto Rico

and searched for worms. The worms passed by each person are then counted and identified as to species. Treatment is usually repeated at ten-day intervals until three treatments in all have been taken.

Advantages of New Type of Survey. The principal advantage of this method of conducting a survey lies in the fact that it yields more accurate information as to the severity of the infection than does the ordinary microscopic search for eggs in the feces. It is especially valuable for determining not only the extent but the severity of hookworm infection in different localities, and the relation of occupation, age, and other factors to the number of worms harbored. By thus indicating more accurately the relative severity of the infection in different localities and among different groups, it enables control measures to be undertaken with greater assurance that the disease is being attacked first in those areas where it assumes its most serious aspect.

VI

HOOKWORM CONTROL OPERATIONS

Nothing could be simpler in theory than the few measures necessary for the control of hookworm infection. The cycle of the worm from the moment the egg is deposited on the ground until it has reached the small intestine of its human host and developed to its adult stage, is well understood, as are also the details of its life-story and environment. In addition, there are at least two drugs which are most potent in freeing the human system of the parasites. It should therefore be comparatively simple to cure those who have the disease, to prevent others from contracting it, and thus to bring about, within limited areas at least, its complete eradication.

Complete Control Never Accomplished. Although the problem of complete eradication is simple when stated on paper, it is not so in practice. The Board has been engaged in work against hookworm disease since 1910, similar work was undertaken in Porto Rico in 1904, and the attack on the disease in the mines of Belgium, Holland, and Germany began as early as 1902; yet it is impossible to point to any one mine or area from which the infection has been completely eradicated. In the mines of Germany it was reduced from 16.8 per cent in 1903 to .18 per cent in 1912; in those of the Netherlands, from 25 per cent in 1903 to .32 per cent in 1913; and in those of the Liege district of Belgium, from 22.8 per cent in 1902 to 1.2 per cent in 1913. These are the nearest recorded approaches to complete control.

Difficulty of Completely Eradicating the Infection. Many obstacles stand in the way of complete eradication, even in isolated areas having no immigration and with natural conditions that either limit or preclude intercourse with the outside world. It is seldom possible to examine every individual in an area or to treat until cured all who are found infected; when latrines of a proper type are installed in sufficient numbers to prevent soil pollution, it is still necessary to accustom the people to their use—and this is a task that usually requires a long period of education and enlightenment; and even when both the foregoing conditions are fulfilled, there still remains for a time the danger of re-infection from hookworm larvae already in the soil.

RE-INFECTION IN TREATED AREAS

The failure to achieve complete control of the infection in any area is probably due in the main to three reasons: first, that in most of the areas of operation effective excrement disposal has not preceded the curative work by an interval of sufficient length to insure a sterile

soil; second, that there has been an error of greater or less degree in microscopic diagnosis; and, third, that there is at present a lack of data on certain points concerning which definite knowledge is essential for control. In six countries during the period under review, a large number of persons who had previously been treated and presumably cured were re-examined in order to ascertain whether infection was recurring in the areas in which they lived, and if so to what extent.

Re-infection in Salvador. In only one instance in which re-examination was made was there found to be an absence of re-infection. This was at an orphanage in San Salvador where among twenty-three children cured of hookworm disease three years previously, there was no evidence of a recurrence of the infection—a result doubtless due to the excellent sanitary conditions prevailing at the institution. In the town of Apopa, Salvador, however, where there are few latrines, an infection rate of 77.3 per cent was found among eighty-four persons cured three years earlier.

Low Rate of Re-infection on Costa Rican Plantations. With the exception of the orphanage in San Salvador, the lowest re-infection percentages recorded were in Costa Rica, where on Aquiares estate only 4.0 per cent infection was found on re-examination of 223 laborers who had been cured eighteen months earlier. On another estate in this country—Rodeo—a rate of 14.4 per cent was found among 191 persons who had been cured from five to eighteen months earlier. On neither estate was every home provided with a latrine: Aquiares had provided but half and Rodeo but one-fourth its homes with this convenience at the close of the curative campaign.

In the canton of Bagaces, where at the time of the inauguration of control measures an infection rate of 72.1 per cent obtained, re-examination in 1919 of forty-four school children who had been cured three years earlier showed an infection percentage of only 2.3. At the time of re-survey 82 per cent of the homes in this canton were provided

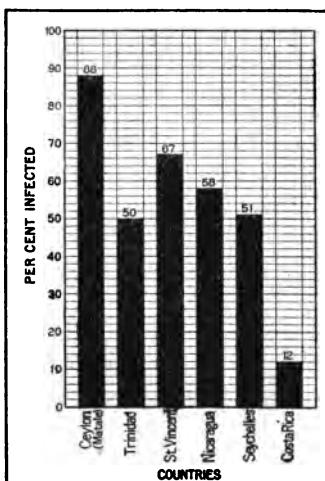


Fig. 50.—Re-infection rates among persons previously treated for hookworm disease, by countries. Interval of twelve or more months between treatment and re-examination

with latrines. In the canton of Liberia, where the original rate of infection was also very high, re-examination showed only 18 per cent infection among 238 soldiers who had been cured three years previously. The low re-infection rates for Costa Rica, however, are in striking contrast to the rates reported for areas in other countries where similar re-examinations were made.

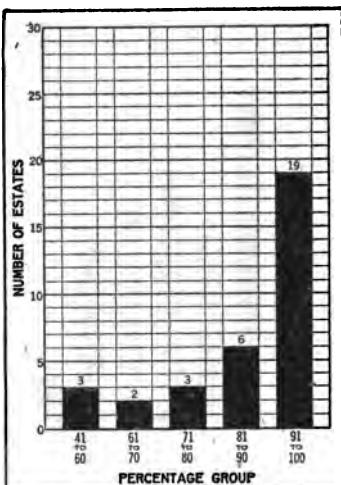
Re-examination of Treated Patients in Trinidad. In Trinidad, where the Ancylostomiasis Commission has been at work for more than five years, where over \$75,000 has been spent on the work of hookworm control, and where 35,000 persons have received the benefit of treatment, investigation was undertaken during 1919 to determine what proportion of the people who had been pronounced cured in the course of the control campaign had become re-infected.

Sixteen districts in which treatment had been given from nine to twenty-nine months previously, were selected for re-survey. These districts were representative of the entire area in type of population and range of sanitary conditions. Conclusions drawn from the re-survey findings can therefore be safely applied to the whole region in which operations were carried out. Re-examination of 1,721 inhabitants of these districts, all of whom had been cured in the original campaign, showed that over 50 per cent had become re-infected. The rates of re-infection ranged

Fig. 51.—Re-infection rates at end of one year or more. Thirty-three treated estates of Matale area, Ceylon. Persons examined, approximately 3,000

in the several districts from 18 to 87 per cent. They varied with the degree of sanitary improvement that obtained in the area. Poorly sanitized areas invariably had more than 60 per cent re-infection, and even those in good sanitary condition had relatively high rates of re-infection if poorly sanitized districts surrounded them. (See Fig. 14, page 31.)

Re-infection Rates in Nicaragua and the Seychelles. The director for Nicaragua states that at the end of eighteen months there was a re-infection rate of 57.9 per cent in the town of Nandismo, where every home had been provided with an approved



latrine during the progress of the curative campaign. Re-surveys, however, revealed the fact that not more than half of these latrines had been used with any degree of regularity. In the Seychelles Islands, among 4,927 persons known to have been cured a year or more prior to their re-examination in 1919, an infection rate of 51 per cent is reported, and this despite the fact that practically every home on the islands is now supplied with some kind of latrine and there is little evidence of soil pollution.

High Re-infection Rates on Estates in Ceylon. It is from Ceylon, however, that the highest rates of re-infection have been reported. On the thirty-three estates of the Matale area whose laboring force was partially re-examined during 1918, after the lapse of at least a year, the average percentage of re-infection was 88 among a total of approximately 3,000 persons examined. The rate ranged from as low as 45 per cent on one estate to as high as 100 per cent on ten. Nineteen of the estates had re-infection percentages between 91 and 100; six between 81 and 90; three between 71 and 80; and only five less than 70. On thirty-eight estates of this area where re-examinations were made during 1919, re-infection rates varied, among persons cured twenty-two months earlier, from 40 to 91 per cent.

In the Bogawantala and Dickoya areas—the two other estate areas completed at practically the same time as Matale—systematic re-examinations have not yet been made on a large number of estates, but the information received from Bogawantala shows that on the three estates for which reports have been received, the re-infection rates at the end of twelve months or more were 70, 88, and 100 per cent.

Re-examinations on Ceylon Estates Completed During 1918. A limited number of re-examinations were made in those estate areas of Ceylon in which operations were terminated during 1918. Three months after completion of work on the estates in the Upper Maskeliya area, specimens from 348 laborers who had been reported

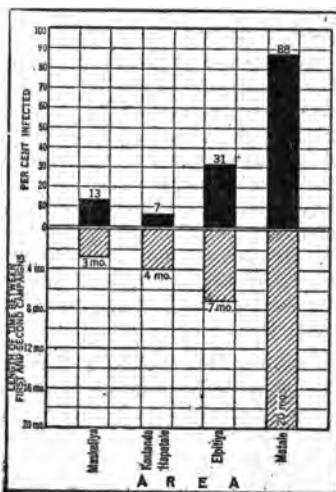


Fig. 52.—Re-infection rates in Ceylon. Relationship between length of time elapsing between treatment and re-examination, and rates of infection recorded

cured, were re-examined and 13 per cent were found to be infected. On nine estates in the Elpitiya area a small proportion of the inhabitants were re-examined from six to eight months after the close of the campaign. Here the infection percentages ranged from 6 to 47, the average being 31. In the Koslanda-Haputale area, among seven estates a number of whose residents were re-examined at the end of four months, the rates ran from 2 to 31 per cent, the average being only 7 per cent. It should be pointed out, however, that in the case of all three of the estate areas last mentioned, the re-examinations were made too soon after the completion of the original campaign. It is to be expected that other re-examinations which will follow at the end of twelve months or more will establish re-infection percentages more closely approaching those recorded for Matale and Bogawantala.

Reduction of Mass Infection First Essential to Control. These high rates of re-infection should not be accepted as indicating that no considerable progress has been made toward bringing the disease under control. It should be remembered that the problem of hookworm control is primarily one of reducing mass infection. The practical phase of the task is concerned with the removal of the largest possible number of worms from the largest possible number of infected persons. Upon this basis the best criterion for judging the effectiveness of a curative campaign in any area is not the percentage of infected persons who are cured or who remain cured, but the proportion, expelled and destroyed, of the total worms harbored by the population.

Factors Determining Percentages of Re-infection. Even though in certain of the areas mentioned, from 50 to 100 per cent of the persons formerly cured of the disease have since become re-infected, there can be little doubt that as a result of treatment the average number of worms harbored by each infected person has been very materially reduced. Conditions extremely favorable for the prevalence and persistence of the infection exist practically throughout all countries in which the work has been conducted; there is at present lack of definite knowledge as to how long larvae remain infective in the soil; the latrine accommodations provided in many areas have been defective or inadequate, the habits of the people grossly insanitary, and in addition war conditions have interfered seriously with due and effective sanitary supervision and reasonable regimentation. Under these circumstances re-infection was bound to occur in greater or less degree, but it will unquestionably diminish as effective sanitation is introduced and the curative measures are extended.

NEED OF SCIENTIFIC KNOWLEDGE ON FACTS ESSENTIAL FOR CONTROL

The fact that after a series of efforts at control in different parts of the globe, extending over a period of more than fifteen years, it is still

impossible to point to any single area from which the disease has been completely eradicated, suggests that perhaps the work is being carried out with a lack of scientific information on certain points concerning which definite knowledge is indispensable if complete control is to be achieved. It is hoped that a series of studies can soon be made which will supply definite experimental proof on those phases of hookworm control that still require further investigation.

Viability of Hookworm Larvae in Soil and Feces. One of the most important factors calling for further study is that relating to the viability of hookworm larvae in soil and feces. In the past it has been commonly supposed that after a period of from six to ten months the soil would become sterile and the disease would gradually die out, but the evidence now at hand seems to indicate that soil once heavily infected—particularly in tropical countries, where the temperature seldom or never drops to the freezing point—must remain infected for a considerable time even after sanitary conditions have been improved. Thus, Kofoid has recently reported that in the soil of California the larvae remained alive for sixteen months, and it is probable that in more tropical climates they persist for even longer periods.

a. Life of larvae in garden soil of China. There was opportunity for limited investigation of this question in China during 1918. In that country much of the soil is under cultivation the year round, assisted by intensive fertilization with human excreta. In the middle of August, 1918, a plot of land in which no larvae could be demonstrated was fenced off. This plot was then divided into three sections. In (A) the ground was dug up in the manner adopted in planting a Chinese vegetable garden, and feces that were known to contain hookworm eggs and larvae were mixed with the soil. In (B) infected feces were merely sprinkled over the top. In (C) the ground was left undisturbed and uncontaminated. The plot of ground selected for the experiment was 1,000 feet above sea level and during the period of five months that had elapsed up to December 31, 1918, had been subjected to temperatures varying from 38° C. to -4° C. (100° F. to 25° F.). The soil in the meantime had been directly exposed to the summer sun as well as to ice and snow.

For the entire five months' period, plot (C) gave negative results. On the other hand, until December, when the cold weather set in, larvae could always be found in (A) and (B) on the first slide examined. Afterwards it was necessary to pour water on the culture to draw the larvae out, and the last time the test was made three slides had to be prepared before a larva was found. The larvae were always actively motile in (A) and (B), and in December were still present in enormous numbers.

In other experiments, conducted during the month of September and again at the end of December, fifteen fields were indiscriminately chosen and samples of soil were obtained and cultivated. All were positive for hookworm larvae.

b. Investigation of larvae viability in storage pits. It is customary for Chinese farmers to store excreta in storage pits after purchasing it for use as fertilizer. An investigation was made during 1918 to determine the probable duration of life of hookworm ova and larvae in these pits. For economical reasons none of the farms visited had feces that had been in storage for more than two and one-half months, despite the fact that the farmers claim that the older the excreta the more valuable it is for fertilizing purposes. On one occasion thirteen pits were visited and on another twelve, and samples of feces were obtained from all. The age of the feces from which the samples were taken ranged from three to seventy-two days. All specimens contained both hookworm and ascaris ova, but larvae were not numerous except on cultivation.

c. Penetration of larvae through sand. Dr. Dershimer investigated this question in connection with his work at the Onderneeming Industrial School in British Guiana. In spite of the fact that pail latrines had been in use in this institution for some time, an unusually high percentage (95.8) of the 142 boys living there were found infected. On investigation it was discovered that the contents of the latrines were buried around lime trees to fertilize them, and that a large proportion of the boys who worked round these trees when the ground was wet subsequently developed ground-itch. A pound or more of sand taken from the surface near the trees was examined microscopically and numerous larvae were discovered. All had worked through two feet or more of sand to gain the surface.

Viability of Hookworm Larvae in Water. Although oxygen is necessary to the development of hookworm ova, and both oxygen and food are required by the young larvae, adult larvae need no food and can survive for a long period in atmospheres completely devoid of oxygen. In fact it has been noted that at this stage of development larvae exhibit a marked preference for a water habitat. Adult larvae observed by Looss remained alive in water for more than 300 days. This prolonged viability of larvae in water would account for the high rate of hookworm infection which obtains among laborers in rice fields.

Transmission of Infection by Flies and Dust. Some data from Arkansas and Texas brought together by means of the laboratory car *Melchnikoff*, during the treatment of infected soldiers in the Southern States, suggest that there is a possibility of the infection being transmitted by dust. This subject is worthy of further study. The role played by insects, particularly flies, in transmitting the infection, also remains to be thoroughly investigated. Miyagawa, in a series of investigations conducted in Japan, found that the water washed from maggots secured in and around latrines yielded, upon centrifugation, several hookworm eggs. The problem of fly transmission was studied to a limited extent in China during 1918. On two occasions several hundred flies of the "blue-bottle" species were

taken from several native latrines. Those from each latrine were placed in separate bottles and thoroughly washed. The water was then centrifuged and microscopic examinations were made. All the specimens gathered from the seven latrines visited on the first occasion showed ascaris and one showed hookworm ova, while those from all five latrines visited on the second occasion again showed ascaris and one showed hookworm ova. The water in which the flies were washed was then cultured by the charcoal method, but no additional hookworm larvae were demonstrated. No explanation can be offered as to why the eggs of one parasite should be found more frequently than those of another, as the percentage of the population infected with both parasites is about the same. The terminating of the fly season prevented further investigation being made of this interesting subject.

MODIFIED WORKING METHODS TO REDUCE MASS INFECTION

It has long been evident that if treatment is to be extended to the hundreds of millions of East Indians, Egyptians, and Chinese, to say nothing of the dense masses of humanity inhabiting other tropical and sub-tropical lands, a means must be found of lowering the cost of the work without seriously impairing its efficiency. The great bulk of the people in these lands are agriculturists, and practically 100 per cent of the adolescents and adults among them are infected. Two means exist of making treatment more readily available for them: (1) preliminary microscopic examination can be omitted in regions of heavy infection, and the time and personnel now employed in this phase of activity can be utilized for actual curative or preventive work; and (2) since it seems neither necessary nor feasible to attempt the immediate removal of the very last hookworm which these persons harbor, a quickly efficient and reliable method of treatment can be developed which can be administered as a routine, with the expectation that effective sanitation and post-campaign treatment will eliminate whatever light infection remains.

Impracticability of Insisting Upon Absolute Cure. Large numbers of worm counts conducted by the Department of Hygiene of the University of São Paulo have shown that two standard treatments ($1\frac{1}{2}$ mils each) of oil of chenopodium remove an average of 95 per cent of the hookworms harbored by an individual, and that three treatments remove an average of 98 to 99 per cent of all worms. To strive for the absolute cure of each infected person—i. e., the removal of the very last worm—often involves a long series of treatments and re-examinations, and besides is in certain other respects an impracticable standard. In present practice by this plan it is not usual for all worms to be expelled. Instead, they are reduced to a

minimum. When microscopic examination aided by the centrifuge is the method of diagnosis employed, there is a material error in first examinations as well as in re-examinations after treatment has been taken—an error which may be conservatively estimated as exceeding 15 per cent. Thus there is considerable unreliability in the very standard upon which cure is based. Then, too, infected cases not detected by the present method of diagnosis not only are given no opportunity to receive treatment for hookworm or for other parasites, but these, as well as the cases inaccurately pronounced cured after treatment, are given the impression that they are free and as a result they continue to spread the disease. There are, moreover, large numbers of persons who cannot be cured, because of refusal to take treatment or for medical or other reasons. This group commonly represents about 20 per cent of those infected. While striving for cures in four-fifths of the infected population, this group escapes and continues to seed its environment.

Mass Treatment Without Preliminary Diagnosis by Microscope. After all, it is not the few worms left after treatment, but the average of 150 or more worms harbored by the great mass of infected and untreated humanity in tropical and sub-tropical lands, that is the important factor in hookworm control. Communities in which the adults have an average of fifty or fewer worms obviously do not require treatment so urgently as more heavily infected localities. Where there is a high rate of infection and the average number of worms per person exceeds fifty, it would seem that the people might be treated *en masse* without preliminary microscopic examination, every person in the group except the very young and very old receiving a routine treatment. Even though in a few instances more than 10 per cent of the worms remained after treatment, this would be offset by the error in microscopic diagnosis under the present plan of work. Therefore, though the modified plan, when considered theoretically, may appear to lack a certain degree of thoroughness, in actual operations by this plan it would seem that but little thoroughness should be lost.

Experimental Plan of Control for Ceylon Estates. Ceylon was the first country in which the modified intensive plan of control was attempted. More than 99 per cent of the Tamil laboring population of this country is infected with hookworm disease. Preliminary fecal examination was therefore omitted in the case of all except 10 or 20 per cent of the laborers on each estate. If the specimens obtained showed over 80 per cent infection, the whole labor force, except persons less than a year old, those physically unfit for treatment, and pregnant women beyond the third month, were given one or two medium doses of chenopodium with an interval of one week between. All were examined clinically to find whether they were fit to take treatment and also to impress them with the scientific soundness and value of the work. Ten days after the first or second treatment,



Fig. 53.—Medical director examining patients to determine their fitness for receiving hookworm treatment. Ceylon



Fig. 54.—Education is one of the most important features of the world-wide campaign against hookworm disease. Two groups assembled in Costa Rica to hear a lecture on the disease. Above, conference at La Unión, province of Cartago; below, conference at Heredia, province of Heredia

fecal specimens were obtained from all those who had been treated, and as a rule it was found that about 70 per cent of those who had had two treatments had been cured. Persons found positive after two treatments were given a third treatment.

Modification of Intensive Plan Tentatively Adopted for Brazil. In Brazil, too, where more than ten million people, scattered over a vast and sparsely settled area, are awaiting treatment, similar effort is being made to accelerate the rate of treatment by conservative modification of the plan originally followed. In certain of the posts in this country it is now customary to take a census that includes every individual and to examine all once, and once only, microscopically. Every individual found infected with hookworm disease is treated twice with oil of chenopodium, with an interval of ten days between treatments. Individuals with hemoglobin below 50 per cent are treated three times without additional microscopic examination, unless malaria is a controlling factor in the anemia. In addition, all persons suffering from any form of intestinal helminthiasis whatever are treated once, as well as all the members of any family which contains even one infected individual. It is believed that this plan of work will reach all infected persons and succeed in eliminating at least 95 per cent of the intestinal parasites they harbor. If at the same time the construction of latrines at all the homes is secured, the community will be permanently protected and the remaining worms will probably disappear. Summed up in a few words the system means: a latrine at every house, education sufficient to insure its proper use, and every infected individual treated at least twice.

Study of Relative Efficiency of Regular and Modified Intensive Plans. The Board is not yet prepared to commit itself definitely to the new plan of work. Before doing this it will have to test, under a wide variety of conditions and in a number of different fields, the relative merits of the regular and the modified intensive plans of work. An initial step in this direction was taken in São Paulo, Brasil, during 1918 and 1919. In one of the two posts maintained by the Board in this state, the standard was set of treating every infected individual to a cure as determined by microscopic re-examination. In the other post, every infected individual was given one microscopic examination and two treatments of chenopodium. In the case of persons with hemoglobin below 65 per cent, three treatments were administered. The conditions of race, infection, and laboratory efficiency were practically the same for both posts. At the first post, in sixteen months, 9,393 persons were treated (587 persons per month) at a per capita cost of \$3.05. At the second post, in $7\frac{1}{2}$ months, 6,720 persons were treated (900 per month) at a cost of \$1.97 per person. From these results it is evident that the modified method insures a great saving of time and expense.

POST-CAMPAIGN MEASURES ON CEYLON ESTATES

Arrangements by which post-campaign measures will be conducted on all estates on which the regular work of treatment has been completed, were made with Government and with the planters of Ceylon during 1917. It is planned to have these measures continue for a period of eighteen months following the close of the initial demonstration in the different estate areas. They will be under the supervision of government medical officers, assisted by microscopist-dispensers trained in regular campaign work. At the end of the eighteen months' period of organized post-campaign measures, the estate dispensers will be expected to handle the situation, which will consist mainly in the treatment of small groups of new laborers coming to the estates from time to time.

Extent of Post-campaign Work to End of 1919. During 1918 and 1919, post-campaign measures were conducted on the estates in the Matale area where the original treatment had been completed during 1917. By the end of 1919 more than 8,000 laborers had received post-campaign treatment. It is significant of the increasing interest in anti-hookworm work in Ceylon that two districts in which campaigns were conducted during 1919 asked that post-campaign measures be carried out in these areas.

Methods Followed in Post-campaign Work in Ceylon. In carrying out the post-campaign work in Ceylon, the plan followed during 1918 and 1919 was to take a complete census of each estate and to distribute tins for excreta to at least fifty coolies taken indiscriminately from among men, women, and children who had been treated in the original demonstration campaign. Examination of the excreta served to indicate roughly what percentage of re-infection had occurred. The medical officer clinically examined every person and prescribed for those who were to be treated. Two treatments, separated by an interval of ten days, were administered, and then the staff left the estate.

Proposed Modification of Post-campaign Methods. In future work it is proposed to modify the plan in the case of those estates on which, after careful survey of the latrines and of a zone within a radius of seventy-five yards around each of the lines or groups of lines, the post-campaign medical officer finds that the latrines are in general use and are being properly kept, and that the zones around the lines are free, and are being kept free, from visible soil pollution. On such estates a third treatment is to be given to all found to be still positive on microscopic examination after the second treatment. This will complete the work on such estates if arrangements are made for the treatment of all new coolies immediately upon their arrival. On all other estates, additional treatments, after the first series, are to be deferred until eighteen months after the close of the original demonstration campaign, by which time specific soil pollution should be controlled.

**RE-CAMPAIGN FOR COMPLETELY ERADICATING
HOOKWORM DISEASE FROM THE SEYCHELLES ISLANDS**

Because of the loyal co-operation which Government and the people of the Seychelles Islands have accorded the work of hookworm control, and also because of the isolation of the islands and their small population, it is believed that this field offers most favorable conditions for the complete eradication of hookworm disease. It was therefore determined that upon completion of the first campaign in the Islands, a re-campaign for the extermination of the disease would be attempted. This second campaign began on June 1, 1919, after control operations had been extended to all of the Seychelles with the exception of the small islands which lie some hundreds of miles from the main group. The second campaign began in the South Mahe area, where the first had been conducted two years before. In August similar measures were undertaken in Central Mahe. By the end of the year 8,964 persons had received post-campaign treatment.

Re-campaign Methods in the Seychelles. The plan adopted in re-campaign work in the Seychelles Islands calls for a census of the entire population, the microscopic examination of all inhabitants for the presence of hookworm infection, and the treatment of all infected persons until microscopic re-examination indicates that they have been cured. Re-examinations are made seven days after treatment; first re-examinations are made after second treatments, and thereafter re-examination follows each treatment. About two months prior to the inauguration of post-campaign measures, government sanitary inspectors visit each home and prosecute all persons whose latrines are not in satisfactory condition.

**CO-OPERATION OF NUMEROUS AGENCIES NECESSARY
TO CONTROL HOOKWORM INFECTION**

Efforts toward the control of hookworm disease are slowly progressing throughout the vast regions of infection. At the rate at which the campaign is marching, however, many years will be required to rid the world of the disease, and enormous rural populations will wait in vain for relief from a great scourge, unless numbers of auxiliary agencies can be organized to assume the burden of systematic and permanent control measures in the various infected areas. Some progress has already been made in this direction, and although these efforts are as yet sporadic and unorganized, they are hopeful signs of an onward movement.

Student and Army Forces as Propagandists. The schools, colleges, and army camps of a country are valuable sources from which the gospel of sanitation and curative work may be spread abroad among the population, and for this reason attention is being

concentrated more and more upon the work of treatment and propaganda among students and military forces. In Siam during 1919, over 2,000 soldiers received treatment for hookworm infection, and in Nicaragua, Salvador, Guatemala, and other areas extensive curative and educational work was carried on among the school children. In Ceylon, lectures, demonstrations, and treatment campaigns were conducted, among other places, at the Government Training College for Teachers, at Colombo, and at the training colony for teachers conducted by the Church Missionary Society at Peradeniya. Teachers go from these institutions into government and mission schools throughout Ceylon. The co-operation of the schools will therefore be of inestimable value in future campaign work.

Co-operation of Business Organizations in the Work of Hookworm Control. In practically all areas in which anti-hookworm operations are being conducted the work has the co-operation of the managers of estates and manufacturing corporations. It is usually the custom for these organizations to allow their laborers a day at home with pay at the time of treatment, and many companies continue systematic examination and treatment of their employees after the original campaign has been brought to a close. The Demerara Bauxite Company of British Guiana, the São Jeronymo Coal Company of Rio do Sul, Brazil, the Pingxiang Colliery of China, the rubber estates of Sumatra, and the cane plantations of Fiji, represent a few of the organizations which are conducting systematic health work among their employees.

Corporations are awakening to the fact that care for the health of their employees will pay dividends in the form of greatly increased production. This fact is evidenced by the number of requests for co-operation in anti-hookworm campaigns which are being received from planters and manufacturers. Twenty large sugar manufacturers in Rio de Janeiro have agreed to furnish \$3,000 a year for three years toward the work of hookworm control among their employees, and a large number of Brazilian coffee planters have agreed to sanitize their plantations and to pay a share of the expenses of curative operations on these plantations. In British Guiana the Planters' Association has expressed a willingness to pay half or even two-thirds of the cost of an anti-hookworm campaign, and in anticipation of the completion of arrangements for this campaign one group of estates has appropriated \$10,000 to cover its share of the cost of the work.

Constant Vigilance the Keynote to Hookworm Control. When the co-operation of every available organization in hookworm-infected regions has been enlisted for the work of control, the solution of the hookworm problem will be in sight. The crux of the problem, however, was well stated by the Governor of British Guiana in a speech at the opening of the Combined Court of that

colony in December, 1919:—"I wish to express my emphatic disbelief in the idea that it is possible by any means whatever to stamp out hookworm disease once for all. The matter must receive constant attention all over the colony. By treatment and by sanitary measures in villages and on estates, it may be possible to reduce the hookworm to an almost negligible quantity, but the disease is like the locust plague in Cyprus. For forty years the crops there have been free from the ravages of these pests, but the scourge would be renewed were it not for the annual campaign against it."

VII

SOIL SANITATION AS A MEANS OF CONTROL

Fecal matter which contaminates the hands and feet is the crux of the hookworm problem. The contamination occurs mostly under rural conditions. The most important undertaking in all efforts to stamp out the disease is therefore to prevent the deposit, on the surface of the ground, of hookworm eggs contained in the feces. This may be accomplished by securing the provision and use of properly built and adequate latrines to serve as receptacles for the contaminated matter. To insure the installation, maintenance, and use of sufficient and satisfactory latrines is, however, a formidable undertaking. It involves the task of inducing hundreds of millions of people in the infected regions to abandon habits ingrained by centuries of usage and often dictated by the religions to which they adhere, and to accustom themselves to new and in some respects difficult habits, the necessity for which they must in some manner be brought to appreciate.

Defining the Problem by Sanitary Surveys. The original sanitary problem of each area of operations is defined by means of a house-to-house canvass during which the facilities that exist at each house for safely disposing of human excrement are carefully noted. This initial sanitary inspection is generally carried out in advance of the curative work. During the past year, statistics have been gathered as to the latrine conditions at homes in 185 rural or semi-rural areas in various tropical and sub-tropical lands. Classing as satisfactory any type of latrine that effectually prevents soil pollution and is fly-proof, only 9,381, or 9.8 per cent, of the homes in these areas were reported to have satisfactory accommodations, while 50,749, or 53.0 per cent, had no accommodations whatever when the curative work was undertaken. The situation on first inspection in a number of widely-separated but typical rural localities is instanced below to show the need of thoroughgoing sanitary reform if soil contamination is to be prevented and hookworm disease eventually controlled. The conditions in the areas mentioned are not unusual, but repeat themselves with greater or less fidelity in the different countries in which control measures are being undertaken.

a. Lack of latrines on São Paulo plantations. The survey of São Paulo completed during 1918 showed that on the coffee plantations of this state the owners' and managers' houses are generally the only ones provided with latrines. As a result, the soil around the coffee plants is infected with larvae and the workers constantly re-infect themselves. The soil is porous and is kept moist by the shade of the

coffee trees, and for the greater part of the year the temperature is fairly high. Conditions are therefore ideal for the eggs to hatch and for the larvae to develop.

b. Sanitary situation in selected areas of Southern States. In the entire rural area of Hart county, Georgia, not a single sanitary latrine was found at the time of first inspection. In South Carolina, among 5,703 homes in three counties, 3,334, or 58.5 per cent, were found to be provided with insanitary latrines of the open-back, open-seat variety. An additional 1,518, or 26.6 per cent, were without facilities of any sort for disposing of excrement. In Texas, only 13.7 per cent of 4,758 homes located in eight counties, had satisfactory conveniences when the work began. Two hundred eighty-five, or 6.0 per cent, had no conveniences at all.

c. Facilities for feces disposal in Queensland and Trinidad. In the infected regions of Queensland, Australia, the pail system, with burial of the contents, was in general use on first inspection, but the latrines were mostly of the open-back, open-seat variety, inadequate for preventing soil contamination. In the Caroni, Maracas, and Laventille areas of Trinidad, the sanitary conditions were reported to be very bad. In the Caroni area there were a number of heavily-infected villages in which not a single latrine could be found.

Methods Followed in Securing Sanitary Improvement. Practically all the states and countries which are carrying on measures against hookworm disease have adopted one or more types of latrines, and have made provision for a more or less complete system of inspection to insure the erection and use of these latrines in sufficient numbers to guard against soil pollution. The staff engaged in the curative work endeavors through its educational activities to bring all the people to appreciate the necessity of providing themselves with some form of latrine that will permit the safe disposal of excrement, and in each instance recommends the type or types of latrines adopted by the Board of Health of the state or country in which the work is being conducted.

INVESTIGATION OF SEWAGE DISPOSAL IN SOUTHERN STATES

The diversity of opinion among public health officials as to the best method of disposing of human excrement in rural communities with limited means, led the National Conference of State and Provincial Health Officers, at its meeting in Washington, D. C., on June 3 and 4, 1918, to urge the Surgeon General of the United States Public Health Service to appoint a special commission to study the subject and make recommendations. Action was taken and an experimental station was established at Wilmington, N. C. Preliminary reports indicate that the problem is even more complicated than was anticipated.

In January, 1916, the Board, recognizing that definite information on the subject would be of considerable assistance to local health authorities, had made provision for carrying out, under the direction of the Rockefeller Institute for Medical Research, a study of the types of latrines commonly used for disposing of feces in unsewered localities. It was hoped that from the facts brought to light it would be possible to evolve a method, or various methods, of disposal that would be safe and practicable under prevailing conditions.

Method of Approaching the Problem. The work was placed in charge of Dr. I. J. Kligler, of the Rockefeller Institute, whose studies, conducted over a period of two years, have sought to test experience under a variety of conditions. The problem was approached from both the field and experimental points of view. In the laboratory, repeated tests were made to determine the viability of typhoid and dysentery bacilli in soil and in excrement under different conditions, their ability to penetrate columns of soil of different degrees of porosity, their viability in septic fluids and effluents, and the nature of the antagonistic factors in soil and in septic material which influence their viability. In the field work, particular attention was paid to the extent of pollution of the soil surrounding privies, and the relationship that privies bear to the pollution of wells. The pit and the septic tank were the types of privies mainly studied, though other varieties, including the pail privy and the chemical toilet, came in for a limited share of attention.

Method of Conducting Studies in the Field. The studies of the septic tank centered on field investigations of thirty Kentucky sanitary privies, which had been in use for periods ranging from four months to three years. The L. R. S. type was investigated only in the laboratory. Practically all the Kentucky privies examined were of the rural type.

The pit privy was tested in five widely separated communities in the state of South Carolina. These communities presented practically all soil formations common to that state. The soil in the first was hard, red clay; in the second and third, sand-clay; in the fourth, sand on a sandstone bed, with a water-table eight to ten feet below the surface; in the fifth, sand and sand-clay. The privies, more than fifty in number, had been used from one to three years, and were studied during both the dry and rainy seasons.

In investigating the pit privy, specimens of soil were taken at different depths and at different distances from the pit, to learn the source and direction of any seepage that might be occurring. The effluent from septic tanks was also collected and examined, the soil samples being taken in the same manner as for pit privies.

Results of the Investigations. The main findings of the survey, subject to confirmation by more extended investigations, are: (1) that typhoid and dysentery bacilli succumb rapidly upon being



Fig. 55.—Accustoming primitive peoples to the use of latrines is fundamental to hookworm control. Type of fly-proof pit latrine, with thatched roof, erected in province of Veraguas, Panama



Fig. 56.—Type of latrine erected for boys' school in Santiago, Panama. Fly-proof, cement lined. Latrines such as this teach the gospel of sanitation to the growing generation

exposed to unnatural environment, consisting either of the effluent from septic tanks, of solid feces, or of soil; (2) that the spread of pollution from a focal point is limited in scope; and (3) that pollution of the wells, when it occurs, is usually derived from the surface. The experiments indicated that the vertical distance between the source of pollution and the ground water level, as well as the character of the soil, are the important factors for consideration in choosing the method to be employed in disposing of sewage. The horizontal distance between the polluted area and the well was found to be of relatively slight importance except where there are underground channels or cracks in the soil.

In moderately compact clay, sand-clay, or sandy soil, free from cracks, the possibility of subsoil pollution of the ground water from pits and septic tanks seems to be negligible if a vertical distance of at least ten feet is allowed between the fecal deposits and the ground water level. The pit privy is not considered safe in limestone regions or in soil where the ground water level is near the surface. For such localities the Kentucky sanitary privy or a privy of similar design, with sufficient storage capacity to allow time for the destruction of pathogenic bacilli, and with the drain placed from three to five feet above the ground water level, is thought to be best.

The results of Dr. Kligler's work will be published during the latter part of 1920 as an appendix to the *Journal of Experimental Medicine*.

Need of Additional Inquiry to Establish Preliminary Deductions. It is recognized that these experiments and tests are only preliminary in character, and that they have not yet been carried far enough for definite conclusions to be drawn from them. Conditions growing out of the war made it necessary to await favorable opportunity for a more extended study of the problem. The further study to be undertaken should include, among other subjects, a thorough investigation of the viability of the eggs of intestinal parasites.

Types of Latrines Recommended. In general, any means of disposal is acceptable if it provides against dissemination of infected material by flies, against pollution of the ground in places accessible to bare feet, and against the contamination of drinking water. Several methods that do this have been proposed. Among them may be mentioned the pit latrine, when fly-proof and so located as not to pollute the drinking-water supply; the fly-proof pail latrine, where the ultimate disposal of the night soil is under careful supervision and is satisfactory; septic tanks properly constructed; treatment of the feces with an effective chemical; incineration plants; and sewerage. There are practical considerations touching upon the relative merits of each of these methods, and in many countries, where the choice lies between two or more forms of disposal, it is

only the cheapest that the people in large numbers can be induced to use. This goes far toward explaining the present popularity of the pit privy.

a. The earth pit latrine. This is the simplest type of latrine. It is inexpensive and easily installed, and in sparsely settled areas where soil conditions give reasonable assurance that the water supply will not be endangered, it may be justifiable to use it. It is not, however, to be recommended for town or village use. Nor should it be employed in low, swampy lands where the ground water level is high, or in limestone regions where the stratified rock comes as close as ten feet from the surface. Where the rock strata are tilted the danger is particularly great. Tunnels made by beetles or other insects may be responsible for contamination between pit and water supply.

b. The concrete vault latrine. A recent development in tight vaults that has given satisfactory results, is the double-compartment concrete vault latrine. The compartments of this latrine are used alternately for periods of at least six months. When a compartment becomes filled, it is completely closed and its contents are allowed to remain untouched during the time the second compartment is in use. During the period of disuse, the excrement in the first compartment diminishes in volume and becomes comparatively inoffensive to handle, especially if a little dry earth or, preferably, lime has been added each time the latrine is used. Experiments are now under way to determine whether this residue would be safe and valuable as a fertilizer. This latrine can be erected in any location. Like the earth pit type, it can be home-made.

c. The pail latrine. This type of latrine, in which a pail, enclosed in a fly-proof compartment, is substituted for a pit or vault, is, next to the earth pit latrine, the most inexpensive type to install. A community can be quickly and cheaply supplied with these conveniences by letting out to one carpenter the contract for the entire number required. The latrine has in addition the advantage of being adaptable for indoor as well as outdoor use. Its capacity, however, is extremely limited, and it should be emptied every few days. It is not to be recommended except for communities having well organized and carefully supervised scavenger service. Moreover, with the present high cost of labor, its upkeep involves considerable expense.

d. The septic tank. The septic tank is based on the principle that when fecal matter is deposited in water in certain proportion and permitted to remain in storage for a suitable length of time, there is propagated a growth of bacteria which converts the greater portion of fecal solids into inoffensive liquid form, thereby facilitating ultimate disposal by absorption into the ground or discharge into streams. The small residue of fecal material which does not yield to the liquefying action of the bacteria settles in the bottom of the

tank. Only at yearly intervals or longer must this accumulation be removed. The cost of maintaining this type of latrine is therefore very small. It involves only the purchase of toilet paper, which must be used because of the fact that other materials clog the latrine and destroy its effectiveness.

The superiority of the septic tank over other types of latrine cannot be questioned. The initial cost of the structure, however, is so high as to make it prohibitive for general use in the average rural community or small town. It is important that the septic tank be carefully differentiated from the so-called septic latrine. The former receives the necessary water supply by means of automatic flushing, while the latter requires that the user add water, from time to time, in required quantities.

e. The chemical latrine. The basic principle of the chemical latrine, like that of the septic tank, is the liquefaction of excrement. In this case the process is accomplished by the action of some caustic substance. The latrine is provided with an iron tank of sufficient size to allow the storage of the liquefied waste for from six months to a year. When the tank becomes filled the liquefied matter is removed, either by drainage into an underground filter-bed or cess-pool, or by being pumped out into a tank wagon. The liquefying powers of this latrine surpass those of the septic tank latrine, and in addition it accomplishes a higher degree of purification and deodorization. It is better suited to indoor use than any other type of latrine. But both its initial cost and the cost of maintenance are high, and in its present state of development the chemical latrine is not permanent but must be replaced from time to time.

f. Incineration plants. A good incineration system effectually prevents the pollution of water in wells, lakes, or streams, and at the same time provides a thoroughly sanitary method for the accumulation and disposition of waste matter. By this method the waste is usually collected in an especially devised container which ordinarily is so planned and constructed as to preclude the possibility of human contact or of approach by flies. When this container has been filled to capacity, the waste is fired and reduced to ashes. The incinerator is then ready for another accumulation. There is one very marked advantage of the incineration method of sewage disposal: it can be used where a sewer system is impractical on account of certain soil conditions, drainage difficulties, discharge outlet, or other obstacles.

g. Sewerage. The water-carrier sewerage system, with safe and satisfactory disposal of the sewage, is, from the standpoint of health and sanitation, the ideal method of waste disposal. It is not always practicable or economically possible to install such a system, particularly in towns or cities with small populations or limited resources, and it is seldom feasible in rural areas. For such localities the health officer may have no choice but to recommend some other less satis-

factory form of disposal. Sewerage is, nevertheless, the one system which can be given unqualified endorsement, and is the one toward which all communities—rich or poor, large or small—should be encouraged to strive.

SOIL SANITATION IN ADVANCE OF TREATMENT

There is a growing tendency for governments to arrange for the proper disposal of excrement in advance of the examination and treatment of the people. Ceylon led the way in this movement. Government regulations enacted in that colony during 1916 required all estates to erect adequate latrines for their laborers before the expiration of one year. As a result, the new estate areas in which work was undertaken during the past three years were provided with latrine accommodations before the curative work was inaugurated. This situation will hold true with respect to all other estate areas that are selected for work in this colony. A similar movement is reported from Brazil, Queensland, the Seychelles Islands, China, Siam, Costa Rica, Nicaragua, Salvador, and from all the West Indian colonies in which work is being conducted or is proposed. The Australian authorities also are reported to be favorably disposed toward making the installation and use of latrines a pre-requisite to the opening of work for hookworm control on the estates of Papua.

Value of Elapse of Dry Season Between Sanitary Operations and Curative Measures. During the original campaign in Nandismo, Nicaragua, a portion of the population received treatment and were provided with latrines during the dry season. Another portion did not receive treatment or inaugurate sanitary measures until after the onset of the rains. Re-examinations made eighteen months later showed that among persons in the former group there was 43 per cent re-infection, while in the latter group a re-infection rate of 67 per cent obtained. Since it is probable that a large part of the re-infection in this area was caused by old soil infection, the disparity in re-infection rates between the two groups indicates that the danger from old soil infection is greatly lessened during the dry season, owing probably to the desiccation of a large proportion of the larvae. This fact suggests that if sanitary work is done in an area far enough in advance to permit one dry season to intervene before the inauguration of curative measures, old soil infection will be reduced to a minimum, and, with the proper enforcement of sanitary regulations, there will be less danger of re-infection.

PRE-CAMPAIGN SANITATION IN WEST INDIAN COLONIES

In every West Indian colony in which measures for the control of hookworm disease were conducted during 1919, and in every colony where it is proposed to conduct work during 1920 or 1921, Govern-



Fig. 57.—Type of fly-proof pit latrine with wooden superstructure. Many hundreds of latrines of this type have been erected on the estates of Ceylon, in an effort to overcome wholesale pollution of the soil



Fig. 58.—New latrine of the bucket type with brick superstructure, erected on the Syston estate. It was on this estate that the first latrine was built in connection with the campaign against hookworm disease in Ceylon

ment has obligated itself to sanitize thoroughly each area of operation well in advance of the inauguration of treatment campaigns. Latrines of a standard type approved by the boards of health of the respective colonies will be required, and permanent staffs of sanitary inspectors will be provided to enforce sanitary regulations. All areas worked during 1919 in Trinidad and Jamaica secured a satisfactory percentage of latrine installation prior to the inauguration of control measures. In Trinidad the Central Board of Health passed a resolution making it an offense punishable by law to deposit human excreta, or to defecate, except in properly constructed latrines, anywhere within a quarter of a mile of an occupied building. For the enforcement of sanitary regulations in this colony seven sanitary inspectors were employed during 1919 and provision was made for the employment of twelve inspectors during 1920.

SANITARY PROGRESS IN CENTRAL AMERICA

In Central American countries exceptional difficulties stand in the way of latrine construction. Most of the inhabitants are so poor that they find it difficult to sustain existence. They have therefore been backward in accomplishing definite results in sanitation. During 1919, however, excellent progress was made in latrine construction in all the republics in which control operations were conducted. These countries, moreover, are developing an effective personnel for the enforcement of sanitary regulations. In many areas earnest effort was made to secure the sanitation of all homes at least six months in advance of treatment campaigns. In Nicaragua, 3,500 latrines were erected, the largest number constructed during any year since the work of hookworm control began, and the greater number of these latrines were provided in areas where it is proposed to establish curative measures during 1920. In the course of the year, Government appropriated \$3,000 for the employment of four sanitary inspectors, and several municipalities contributed funds to maintain local inspectors.

In Costa Rica, Government furnished eleven inspectors to enforce sanitary regulations, and each municipality in which work was conducted furnished at least one. In the counties of Alajuela and Tibas, municipal inspectors started compulsory latrine construction three months prior to the inauguration of control measures. Salvador reports greater progress in sanitation during 1919 than in any previous year. Several municipalities in this republic claim to have secured the pre-campaign sanitation of 60 per cent of their homes. These encouraging results are due in large measure to the earnest co-operation of government officials. During the year the President of Salvador sent a letter to governors of departments, suggesting that latrines be erected by every householder throughout the departments, and that monthly reports of latrine construction be forwarded

regularly to him. The Minister of Public Instruction issued an order that all schools be provided with latrine facilities and that inspectors be appointed to enforce the ordinance. Attention was also concentrated during the year on the erection of latrines at military barracks. In Panama, Government put into execution a decree making the construction of latrines obligatory throughout the country. The number of latrines erected in the interior of this country during the year, surpassed the total number built during all previous years of work.

ESTATE SANITATION IN CEYLON

Before the opening of work against hookworm disease in Ceylon, few estates had latrine accommodations for their labor, and the houses in the villages were seldom equipped with sanitary conveniences. Now practically all estates have latrines. From the beginning of work in January, 1916, up to the end of 1918, approximately 50,000 latrine compartments, sufficient to provide accommodations for 700,000 persons had been installed. The great problem now confronting campaign workers is to bring about the use of the latrines that have been built.

Difficulty of Enforcing Use of Latrines on Estates. On all the estates the latrines are used to greater or less extent, but there is still considerable evidence that the soil is being polluted. This pollution commonly occurs about laborers' quarters and along bridle paths. The estate superintendents' efforts to improve sanitary conditions will require time to yield results, as the laborers are indifferent in using latrines. Nevertheless, it is encouraging to report that the number who do use them is steadily increasing.

Adequate System of Latrine Inspection Needed for Estates. During 1919 Government issued a decree making soil pollution an offense punishable by law. It now remains to establish a regular system of inspection to bring about the proper use of latrines and as a last resort to apprehend offenders. The Senior Sanitary Officer has a competent body of trained sanitary inspectors, but their activities are confined in the main to sanitary board areas and to special districts where conditions are particularly unsatisfactory. The extension of this work to reach all of Ceylon is to be the next step.

VILLAGE SANITATION IN CEYLON

Much of the infection and re-infection on estate areas is probably acquired in the villages and bazars included within the boundaries of these areas or situated closely adjacent to them. Until recently no latrines had been erected in these localities, but Government,



Fig. 59.—Different countries employ different means of guarding against soil pollution. Type of pail latrine adopted for use in Queensland, Australia. Manufactured and sold in wholesale lots



Fig. 60.—Example of one of the better methods of night soil disposal. Type of incinerator adopted for use on all estates belonging to Messrs. George Steuart and Company, Ceylon

recognizing the futility of treating and curing the estate laborers only to have them re-acquire the infection on their visits to the villages or to the largely patronized bazars, has lately issued orders to the village headmen and other authorities to have latrines constructed for village and bazar communities. In the Matale area the sanitary department has had from two to four qualified inspectors at work for more than three years, extending the latrine and privy system throughout the villages. Nearly 3,800 village latrines were erected in this area during 1919. In the village communities in or near other estate areas in which treatment campaigns were conducted up to December 31, 1919, many additional latrines have been installed, but the absence of an adequate system of inspection has sometimes resulted in these latrines being of an inferior type.

Installation of Latrines in Southern and Western Provinces. It is estimated that in villages located in other parts of the colony, between 75,000 and 90,000 latrines have been built since the beginning of 1916, nearly all of them by the villagers themselves. Of these, 480 were installed in 1916 and 25,215 in 1917. About 12,000 were erected in 1918 and over 37,000 in 1919. In the rural parts of the Southern province, with a population of about 600,000, privies to the number of 45,000 have been erected during the past three years, more than 40,000 of them during the past eighteen months. These are sufficient to provide accommodations for at least 200,000 persons.¹ The villagers built all of these latrines without prosecution and are using them without reluctance. By special tax and with a government grant and loan, 40,000 rupees were made available for the erection of latrines in two towns of this province—Matara and Weligama—during 1919. Extensive sanitary improvements have also been made at Minuwagonda and surrounding villages in Western province. Here the whole township, with a population of about 9,000, and the villages within a two-mile radius, having a combined population of 3,000 or 4,000, have been provided with sufficient latrines. Sanitary surveillance is to be maintained by qualified inspectors, who will also carry on educational work, including lantern talks, on health subjects. In the whole of Western province during 1919, more than 10,000 latrines were erected.

Latrine Building As Means of Interesting Villagers in Hook-worm Relief Measures. Paradoxically, the installation and use of latrines afford the best entering wedge for work among the Singhalese villagers who form the permanent population of Ceylon. Lantern talks by native dispensers gain the sympathy and interest of the villagers, lead to extensive privy building, and later to a request for the establishment of dispensaries to extend to the villagers the opportunity of being treated. If opportunity for treatment is held out to them as a preliminary first step, they refuse; but after they

¹These figures take no account of local board or sanitary board activities.

have been brought to install latrines in large numbers and to realize the benefits which attend their use, effective curative work can readily be conducted among them.

SOIL SANITATION IN BRAZIL

In Brazil extensive provision is being made for the sanitation of rural areas. The states of São Paulo, Minas Geraes, Paraná, Bahia, and Rio de Janeiro have already adopted rural sanitary codes requiring the provision of latrine accommodations at every home within their jurisdiction. Under forthcoming regulations of the National Department of Public Health, any state accepting aid from the Federal Government for control of rural endemic diseases must adopt a modern rural sanitary code prepared by the department. The Federal Government will appoint officials to execute the law within each state. The greatest progress made in soil sanitation in Brazil during 1919 was on Governor's Island where, by the end of the year, all but a dozen of the 8,000 homes were provided with latrine accommodations.

INSTALLATION OF LATRINES IN THE SEYCHELLES ISLANDS

During the three years in which control measures have been in operation in the Seychelles Islands remarkable progress has been made in sanitation. When work was begun there in 1917 hardly a latrine was to be found anywhere in the colony outside of the town of Victoria. By the end of 1919, however, it was difficult to find a home on the islands unprovided with latrine accommodations. Sanitary laws are strictly enforced throughout the colony and most of the latrines are kept in good repair. There are few instances of soil pollution, and such offenses of this nature as do occur are usually traceable to children. On the islands of Praslin and La Digue, where curative work was conducted during 1919, over 98 per cent of the homes were supplied with good pit latrines before control measures were undertaken. The government of Mauritius has recently given \$32,400 to the Seychelles Government, and the Governor has sanctioned the use of as much of this sum as may be necessary for the installation of public latrines at the most convenient locations throughout the Seychelles.

LATRINE PROVISION IN QUEENSLAND

Scarcity of labor and the almost prohibitive cost of lumber have stood somewhat in the way of complete compliance with the health act of Queensland, which empowers local authorities of each shire or township to enforce latrine construction throughout their districts.

To counteract the difficulties of securing labor and material, a standardized box latrine unit has been adopted which can be manufactured in large quantities and can have placed upon it any superstructure that the householder may have available. This device reduces the cost of a unit to about \$10, a price usually within the reach of the householder. A high percentage of latrine improvement was secured during 1919 through the co-operation of the town councils, which are enforcing throughout their jurisdictions the installation and use of sanitary devices for sewage disposal. Several towns in the state have let contracts for incinerators for night soil disposal, each of these devices to cost approximately \$5,000.

SANITATION OF THE SOIL IN SOUTHERN STATES

During recent years considerable progress has been made in soil sanitation throughout the Southern States, and the movement is steadily gaining momentum. Harrison, Stone, and Jackson counties, of Mississippi, report that an improved latrine has been installed at every one of their rural homes. Harrison was the first county in the South to achieve this enviable distinction. The work done in this area afforded practical illustration of what can be accomplished in health protection, and stood out as one of the prominent movements in the state. In various other Southern counties the record of latrine construction for rural homes ranges between 50 per cent and 100 per cent. Nine state boards of health report that during 1919 an aggregate of 12,250 new latrines were erected and 6,660 old latrines were improved. In North Carolina, the General Assembly enacted a state-wide sanitary latrine law which requires all latrines located within 300 yards of a home to be constructed and maintained in a manner satisfactory to the State Board of Health.

HEALTH IMPROVEMENT FOLLOWING SOIL SANITATION

Hookworm disease is not commonly a reportable disease. Consequently there are few morbidity or mortality statistics to aid in ascertaining its prevalence at any particular time. Following the inauguration of control measures in nine counties of North Carolina, the rate of hookworm infection was reduced from 35 per cent for the years 1911-1914 to 19 per cent for the years 1917-1919. In the Pinghsiang Colliery, China, where sanitary regulations are being strictly enforced, the incidence of infection among the mining population has been reduced from 85 per cent in 1917 to 36 per cent in 1919, and in the Seychelles Islands the infection rate shows a reduction from 96 per cent in 1917 to 51.1 per cent in 1919.

Typhoid fever is a reportable disease, and interesting statistics are available showing the reduction in morbidity and mortality rates for this disease, following the use of adequate latrines. In Orangeburg county, South Carolina, where a rural sanitary campaign has been in progress for three years, the typhoid death rate has been reduced 75 per cent, and in Darlington county in the same state, a two-year campaign has reduced the death rate from this disease 80 per cent. As practically no typhoid inoculations have been given in these areas it would seem that soil sanitation was the controlling factor in this reduction. Adjoining these counties are several counties where no sanitary work has been done. In two of these the typhoid death rate for 1919 showed an increase of 200 per cent, and in another, an increase of 25 per cent, over the preceding year.

In Troup county, Georgia, where in the course of a two-year health campaign 2,895 sanitary latrines were installed, there has been a marked decrease in the incidence of typhoid fever and dysentery. Morbidity statistics for 1919 show typhoid fever to be only about 30 per cent, and dysentery about 12 per cent, as prevalent as before the work of sanitation was begun.

Vital statistics for the year 1919 for Smith and Gibson counties, Tennessee, show very definite diminution in morbidity and mortality rates for intestinal diseases, following rural sanitary campaigns inaugurated in those areas in May, 1919. Smith county reports a reduction of 50 per cent in the number of typhoid fever deaths. In deaths from typhoid fever and all other intestinal diseases combined, there was a reduction of 55 per cent. Gibson county shows a reduction of 20 per cent in the incidence of typhoid fever, and of a fraction more than 50 per cent in that of intestinal diseases inclusive of typhoid.

In Stone county, Mississippi, an intensive campaign against soil pollution was begun in May, 1918. At this time there were less than a dozen sanitary latrines throughout the entire area. By June 1, 1919, when intensive operations were completed, every home in the county had been provided with an improved latrine. During the first six months of 1919, for the first time in the history of the county, not a single case of typhoid fever was reported. In the same state, in Marion county, an intensive sanitary campaign was waged from February 1 to December 31, 1919. At the beginning of the work less than 1 per cent of the homes met the sanitary requirements of the state board of health. By December, as many as 1,192 homes had sanitary latrines. County statistics for the year show a decrease of 25 per cent in typhoid fever cases and of 68.9 per cent in cases of amebic dysentery.

In Fairfax county, Virginia, where a crusade against soil pollution was begun in April, 1917, there has been a notable decline in typhoid incidence and mortality. In 1917 the morbidity rate for this disease was 2.0 per thousand and the mortality rate .13 per thousand. In 1918 the morbidity rate fell to .5 per thousand and no deaths

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occurred. In 1919 the morbidity rate was .34 per thousand and the mortality rate .04 per thousand.

In the town of Salisbury, North Carolina, where in 1918 a sanitary latrine was built at every home not connected with a sewer, there were only two cases of typhoid fever during 1919, as against forty-three cases during the preceding year. In the entire state of North Carolina during 1914, the first year in which deaths from all causes were recorded, there were 839 deaths from typhoid fever. Since that year there has been steady progress in rural sanitary work throughout the state, and a correspondingly steady decrease in the incidence of typhoid fever. In 1919 there were only 427 deaths from this disease, or 412 fewer deaths than in 1914. Each death from typhoid means at least ten cases. A decrease of 412 in the number of deaths means, therefore, the prevention of 4,120 cases of the disease. Rosenau places the average cost of a case of typhoid fever at \$400. On this basis the prevention of 4,120 cases of typhoid may be estimated as having saved the state about \$1,648,000 a year. The prevention of typhoid is but one of many beneficial results of soil sanitation.

VIII

MALARIA CONTROL

Measures for the control of malaria in densely populated communities, by means of the prevention of mosquito breeding, were inaugurated early in 1919 in four Arkansas towns: Eudora, McGehee, Blissville, and Tillar. In addition, supervision was given throughout the year to the maintenance of conditions which had been established as the result of the earlier efforts at mosquito control, by the same means, which had been carried out in six other Arkansas towns: Crossett, Hamburg, Lake Village, Dermott, Monticello, and Bauxite. The program was carried out in conjunction with the United States Public Health Service, the municipalities concerned, and the Arkansas State Department of Health.

Malaria Control by Anti-mosquito Measures: in Towns. The plan of operations followed in the original work at Crossett and Hamburg, with improvements suggested by experience or required to adapt the work to local conditions, was followed in the four towns to which the work was extended during 1919. For the four communities combined, physicians' calls were reduced from 3,394 (the average for the two previous years) to 1,120 in 1919—a reduction of 67 per cent. The per capita cost of the entire work, with overhead expense omitted, was \$0.60. The results and costs by communities are shown graphically in Fig. 61, page 149.

The maintenance record for the towns of Crossett, Hamburg, Lake Village, Dermott, Monticello, and Bauxite, in which control measures had been inaugurated in earlier years, is exhibited graphically in Fig. 8, page 17. Fig. 62, page 150, gives the percentage of reduction and the per capita cost of the work in these towns, as ascertained over the whole period of operations. The statistics demonstrate the practicability of anti-mosquito measures as a means of controlling malaria in communities of this type, from the standpoint both of expense and of degree of control attained.

Extension of Anti-mosquito Measures to Towns in Other States. The success of the extra-cantonment work for the control of malaria, as conducted by the United States Public Health Service during the war, and of the demonstrations in malaria control which have been conducted in Arkansas over the four-year period extending from 1916 to the beginning of 1920, have led to the development of a program for continuing the work in Arkansas and for extending it to selected towns in nine other southern states. The plan calls for joint participation by the United States Public Health Service, the state boards of health of the respective states, selected towns in each state, and the International Health Board. Surveys were begun during the latter part of 1919.

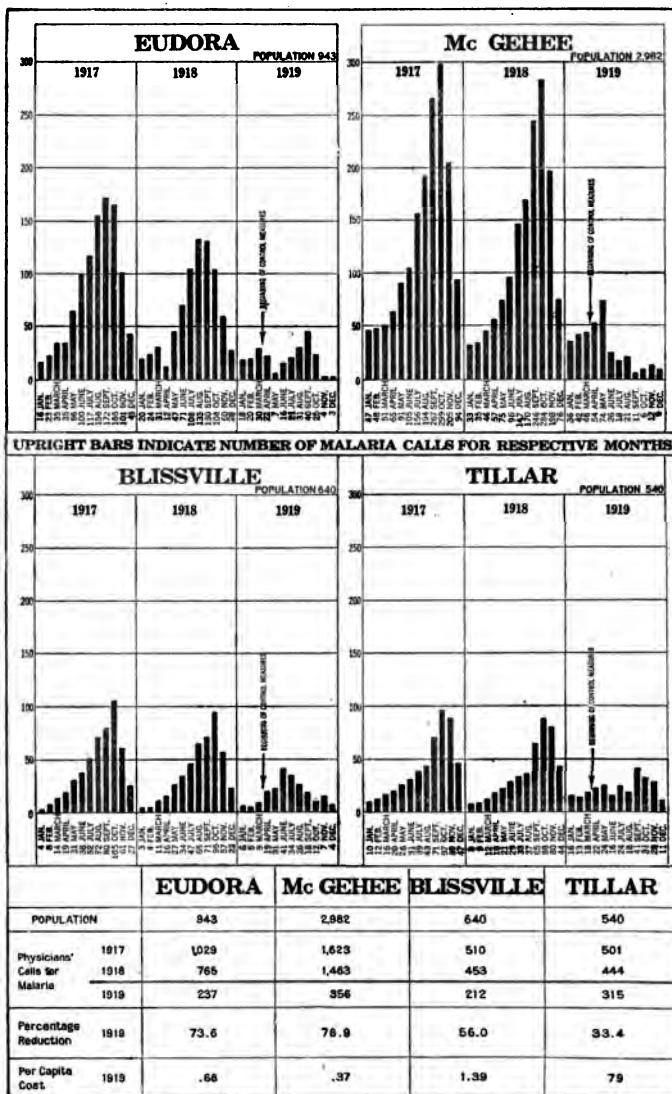


Fig. 61.—Record of malaria control in four Arkansas towns. Work was inaugurated in these four towns in 1919

	CROSSETT	HAMBURG	LAKEVILLAGE	DERMOTT	MONTICELLO	BAUXITE
POPULATION	2,028	1,285	975	2,760	3,023	2,500
Physicians' Calls for Malaria, ⁵ 1916	2,600	.....	.....	.....	.....	.....
1917	241	2,312	1,617	1,999	1,413	962
1917	200	215	1,644	1,245	1,274	775
1918	78	59	83	762	137	172
1919	77	33	96	84	81	47
Percentage of Reduction for Entire Period of Work	96.9	98.6	94.0	93.6	94.0	94.1
Per Capita Cost, ⁶ 1916	\$1.24	\$.....	\$.....	\$.....	\$.....	\$.....
1917	.65	1.45	.....	.....	.....	.....
1918	.53	.44	1.25	.54	.44	1.11
1919	.62	.76	1.08	.65	.44	1.14

Fig. 62.—Results and costs of anti-mosquito measures in six Arkansas towns, 1916-1919

The new program contemplates that operations will be limited in the main to towns of from 500 to 6,000 inhabitants. Co-operative work is proposed for forty towns, having an aggregate population of 177,320, located in seven states: Alabama, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia. Excessive rainfall and a shortage of sanitary engineers caused a temporary delay in completing the programs for Arkansas, Georgia, and Tennessee. It is hoped that the strategically located demonstrations over wide areas in the South will eventually lead to the organization of state-wide crusades for reducing the prevalence of the disease in the various commonwealths of the United States which now suffer from malaria.

Malaria Control by Anti-mosquito Measures: At Scattered Farm Homes. The field work in Arkansas having demonstrated the feasibility of anti-mosquito measures as a means of controlling malaria in selected urban communities, Dr. H. H. Howard began, in June, 1918, a series of investigations to test the practicability of controlling malaria in rural regions. For these studies a rural district was selected in the northern part of Hinds county, Mississippi. This district has an area of approximately thirty-six square miles and a population of 830. During the year 1918 work was limited to a survey of the district and to a study of mosquito breeding within the area. Early in 1919 plans for mosquito control were put into operation in a selected area of twenty-two square miles within the district previously surveyed. It was decided that the remaining fourteen square miles of the area surveyed should be kept under observation but should not be included in the actual control operations.

Results of 1919 Control Measures in Hinds County. During 1918 there was 18.1 per cent of clinical malaria among the 595 inhabitants in the section of Hinds county above referred to; under control



Fig. 63.—One phase of mosquito control in rural regions. Mill pond in Hinds county, Mississippi. Was breeding anopheles continuously throughout season



Fig. 64.—Same pond as in Fig. 63, after being drained, cleaned, and edged. The control operations put a stop to breeding in this pond



Fig. 65.—Pond in Hinds county, Mississippi, after being cleaned and edged, and stocked with top minnows. Mosquito breeding in this pond was satisfactorily controlled by the use of fish

work the rate for the same area during 1919 was 5.5 per cent. The reduction for 1919 was therefore 69.2 per cent. In the section of the county which was kept under observation but not covered by the control campaign, the incidence of infection among the 214 inhabitants was 17.3 per cent during 1918, as against only 10.3 per cent during 1919—a reduction of 40.5 per cent. Taking 40.5—the reduction rate for the area not under control during 1919—as the normal decrease that would have occurred without systematic efforts to reduce the incidence of infection, the reduction that resulted from the control measures may be estimated at 28.7 per cent.

Cost of 1919 Operations in Hinds County. In anti-mosquito work in rural regions the large area to be controlled per individual makes it extremely difficult to maintain low per capita costs, and thus bring the work within the means of the people. The total cost of the operations conducted in Hinds county during 1919 was \$1,550.90, without overhead expense; the cost per capita, on the basis of a population of 595, was therefore \$2.60. This cost is high in comparison with the figures established for the Arkansas towns, and it still remains to be demonstrated that effective malaria control can be accomplished within the resources of local communities. During 1920 further effort will be made to reduce the per capita cost to the lowest possible figure consistent with a satisfactory degree of control.

Use of Top Minnow to Prevent Mosquito Breeding. The chief feature of the 1919 experiment in Hinds county was a thorough test of the efficacy of the top-feeding minnow (*Gambusia affinis*) as an agent in the prevention of mosquito breeding. This fish was used especially to destroy mosquito larvae in stock ponds and other similar breeding places. Heavy rains greatly retarded the progress of operations, and it was not until July 1 that effective control measures could be applied throughout the area. By September 30, however, 88.7 per cent of all the mosquito-breeding places in the area were being controlled, with a large measure of success, by top minnows alone. These agents continued their work until cold weather intervened and stopped mosquito production. If the further tests to be conducted with these fish in Hinds county during 1920 substantiate the earlier indications, this simple and inexpensive measure will doubtless be widely employed as a recognized agency for reducing malaria in regions where conditions will permit of its use.

MALARIA CONTROL BY TREATING THE CARRIERS

The control of malaria in sparsely settled and frequently flooded rural areas is more difficult than in towns or rural areas where the prevention of mosquito breeding by oiling or draining is economically feasible. In the former regions, the method of attack most commonly relied upon is that of attempting to destroy the parasite in the

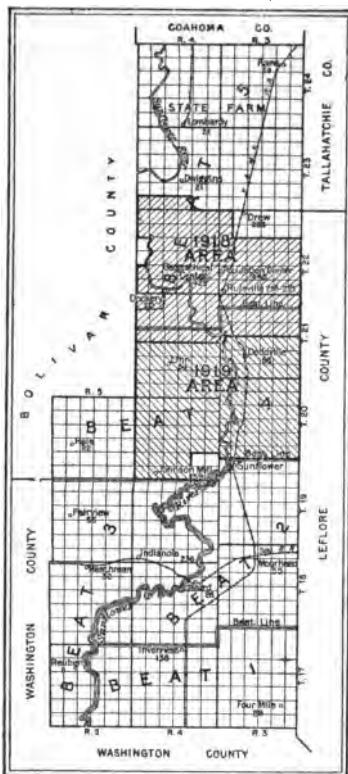


Fig. 66.—Map of Sunflower county, Mississippi, with location of 1918 and 1919 demonstration areas in malaria control by treatment of carriers

county by discontinuing the free distribution of quinine and substituting mass education for the house-to-house propaganda of the previous year. It was soon learned, however, that with the personnel available the contact with the people was not intimate enough to result in large numbers taking quinine regularly for a period sufficiently long to immunize their blood. The treatment campaign was accordingly restricted after July 1 to an area of 110 square miles, with a population of approximately 5,500. The plan pursued here was similar in all respects to that followed in the 1918

blood of the human carriers. A two-year field experiment in control measures by this plan was carried out in a section of Bolivar county, Mississippi, during the years 1916 and 1917. During 1918 and 1919 the control measures developed in the initial experiment were given trial in two limited areas of Sunflower county in the same state. The demonstrations conducted in the latter areas during the last two years have been suggestive, but far from complete. They will need to be continued over a period of years and under a variety of conditions, in this and in other areas, and with a greater measure of success, before they can be regarded as definite and final.

Plan of Malaria Control Work Pursued in Sunflower County. The first demonstration in malaria control by treating the carriers was undertaken in Sunflower county in 1918. It was conducted in an area of 100 square miles, and was based upon the gratuitous distribution of quinine to the people as a means of curbing malaria attacks and driving the parasites from the blood. When the 1919 work was projected it was thought that operations might be extended to the entire

work, except that no free quinine was provided. Throughout the remainder of the county, publicity work and the sale of quinine at cost were continued.

Results of 1918 Efforts in Sunflower County. Re-surveys were made during 1919 in more than half of the communities of Sunflower county in which anti-malaria operations had been conducted during 1918. Each community was re-visited approximately twelve months from the date of the first survey. Record was taken of the number of malaria attacks that had occurred in the interval; blood examinations were made; and for the first time during the demonstrations of control by the treatment of carriers, figures were compiled showing

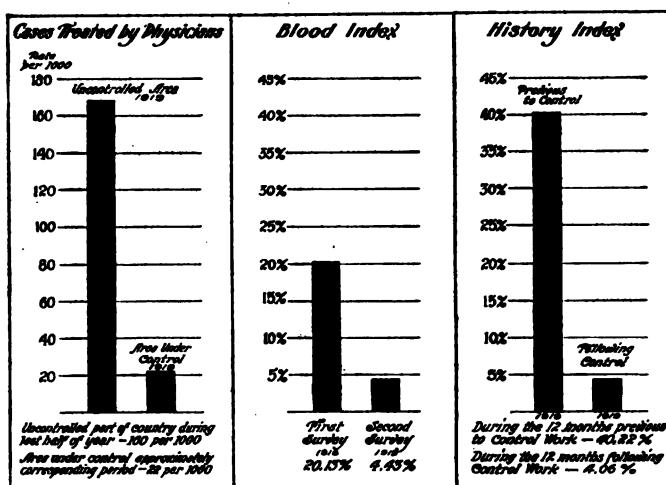


Fig. 67.—Reduction of malaria through treatment of carriers. 1918-1919 control areas in Sunflower county, Mississippi

the number of physicians' calls for malaria. The figures for physicians' calls covered the record for the county as a whole. Fig. 67 shows graphically the reduction in malaria accomplished by the control operations, as indicated by each of the three separate measures of results: history index, blood index, and physicians' calls. As based on history index, the 1919 incidence was 90 per cent lower than that of 1918; as based on blood examination, 78 per cent lower. The record of physicians' calls indicated, furthermore, that within the restricted area where control measures were applied, the 1919 incidence of malaria was 87 per cent lower than throughout the county as a whole.

Cost of 1918 and 1919 Control Demonstrations in Sunflower County. During 1918 the per capita cost of the intensive control measures conducted in Sunflower county, within the selected area of 100 square miles, was \$1.08. The per capita cost of operations within the area of 110 square miles chosen for the control demonstration of 1919, was approximately \$1.09. From the evidence at hand it appears that within this area the disease has been measurably reduced at a per capita cost well within the means of the average rural community, and that in addition the fundamental facts concerning malaria and its treatment have been brought to the attention of a large proportion of the county's entire rural population.

STUDIES IN QUININE ADMINISTRATION

The administration of quinine by mouth quickly destroys the adult germs, but the spores are not so readily reached and killed. Within the last twenty years quinine in enormous quantities has been administered in various parts of the world, particularly to soldiers or other persons who visit malarious districts. Many investigations have been made as to the effect on the human system of different dosages of the drug under varying conditions of treatment, and as to the efficacy of the drug in curbing acute attacks and driving the parasites from the blood. This was one of the points that was given foremost consideration in the early experimental work in Bolivar and Sunflower counties. More than 25,000 cases were closely observed over a period of three years.

Standardized Quinine Dosage Used in Bolivar and Sunflower Counties. The standardized immunizing dosage adopted as a result of the experiment was ten grains daily for eight weeks for adults, with graduated doses for children. For curbing acute attacks in adults, a dosage of ten grains three times a day was adopted. The proportionate dose required to produce in children of different ages the same effect as the full dose produces in adults is shown below:

<i>Age</i>	<i>Proportion of Adult Dose</i>	<i>Dose for Children of Different Ages as Based on Adult Dose of 10 grains</i>
Under 1	0.05	½ grain
1 year	0.1	1 grain
2 years	0.2	2 grains
3-4 years	0.3	3 grains
5-7 years	0.4	4 grains
8-10 years	0.6	6 grains
11-14 years	0.8	8 grains
15 and over	1.0	10 grains

Administration by mouth was the only method used except in rare instances. The administration of the dosage every day for eight weeks disinfected 90 per cent of the infected persons to whom it was administered. The remaining 10 per cent, who suffered from acute attacks, had to be given ten grains three times a day for three or four days, and then ten grains daily for eight weeks. Daily administration disinfected a considerably larger proportion of cases in a given length of time than intermittent treatment on one or two days of the week. The entire eight weeks' treatment was prescribed at one time, and the patients were advised and urged to take it without missing a single day. Otherwise, it was pointed out to them, there was a possibility of relapse.

Adoption of Standardized Immunizing Dose of Quinine by National Malaria Committee. Other investigators in different parts of the world have suggested the same immunizing dose of quinine as was adopted for the experimental work in Bolivar and Sunflower counties. The National Malaria Committee has adopted the dosage, and has recommended it to the publishers of medical textbooks and to practicing physicians. The method offers hope of contributing in no small degree to the control of the infection. Already there are indications that it is being extensively employed by physicians, plantation owners, and the public in general.

IX

CONTROL OF YELLOW FEVER

The operations for freeing Guayaquil, Ecuador, from yellow fever, which were begun on November 25, 1918, were continued throughout 1919. Preceding the inauguration of these measures a Yellow Fever Commission visited Guayaquil, and during a stay of two months made an intensive study of the disease and of the sanitary conditions under which it had persisted. Dr. Hideyo Noguchi, a member of the commission, conducted a series of laboratory investigations in the course of which he succeeded in isolating an organism which is apparently the causative agent of yellow fever. The curative serum and the immunizing vaccine which he prepared as a result of his Guayaquil work were used during 1919, and gave indications of developing into important agents for the cure as well as the prevention of the disease.

Control Measures Pursued in Guayaquil. Aside from the isolation, behind metallic screening, of all suspicious cases indicative of yellow fever, the chief feature of the control program put into effect in 1918 and 1919 was the prevention of *Stegomyia* propagation by the covering of tanks; by drainage, ditching, and oiling; and by the use of fish to devour mosquito larvae in water barrels and miscellaneous small containers. In the carrying out of the work the city was divided into districts of such size as to permit weekly house-to-house inspection by the sanitary squads. Fig. 68 shows the division of the city into working districts at the period of greatest expansion. Government authorities and the people entered heartily into the control efforts, and gave the measures their warmest support throughout the entire course of operations.

Success of Control Work in Guayaquil. The average number of cases of yellow fever in Guayaquil annually during the period from 1912 to 1918 was 259. During 1918 there were 460 cases. The statistics for 1919 show a record of 150 cases for the period from January to May, and an entire absence of cases during the remainder of the year. Fig. 9, page 19, gives a record of the monthly incidence of the infection during 1918 and 1919. The disease appears to have been brought under control, but it is proposed to continue active operations, with a reduced personnel, throughout the year 1920. As a final safeguard against the recrudescence of the disease, the entire region will be kept under observation for at least a year after the disappearance of the last evidence of the infection.

YELLOW FEVER IN CENTRAL AND SOUTH AMERICA

Outbreaks of yellow fever were reported during 1919 from Peru and Brazil in South America, from Honduras, Salvador, and Nicaragua in Central America, and from Mexico. In the Canal Zone one case of the disease was detected upon a vessel in quarantine, in a person who had recently come from Nicaragua. This was isolated and no further cases occurred. In the opinion of competent authority, ports which control the breeding of *Stegomyia* mosquitoes are in no danger even if a case of yellow fever is introduced.

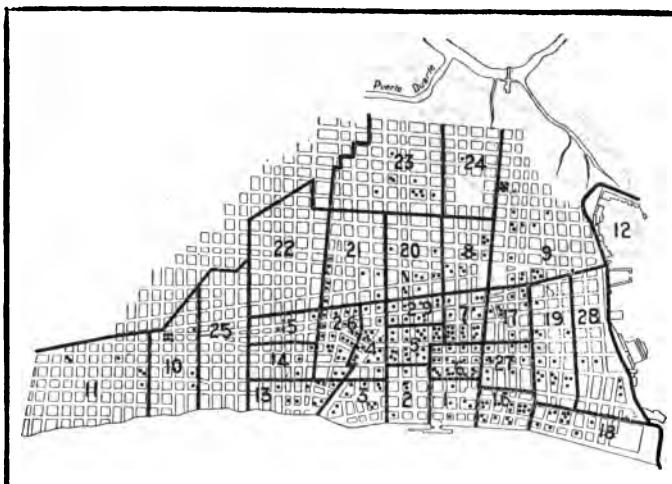


Fig. 68.—Map of Guayaquil, Ecuador, showing division of city into working districts, at period of greatest expansion. Each spot indicates a case of yellow fever. Note concentration of cases near center of city where water tanks are most numerous

The 1918 Outbreak in Guatemala. The report for 1918 told of an epidemic of yellow fever which had developed in Guatemala in June of that year, and had involved seventeen small communities, most of them on or near the west coast. The infection had been introduced into Guatemala from Tapachula, Mexico. Investigation indicated that the disease had spread from its endemic focus in Merida, Yucatan, and had reached Tapachula either by an overland or coastwise route by way of Puerto Mexico, thence proceeding along the route of the railroad (see map, Fig. 69). The total incidence of the disease in the seventeen communities was over 550, with a death rate of approximately 36 per cent.

Bringing Under Control the Guatemalan Outbreak of 1918. Operations for freeing Guatemala from yellow fever were inaugurated in July, 1918, under the immediate direction of Dr. Joseph H. White. Quarantine was established and maintained, a system of daily house-to-house inspections was instituted in each community, suspected cases were isolated, and measures were carried out for the destruction or control of the breeding places of the *Stegomyia*

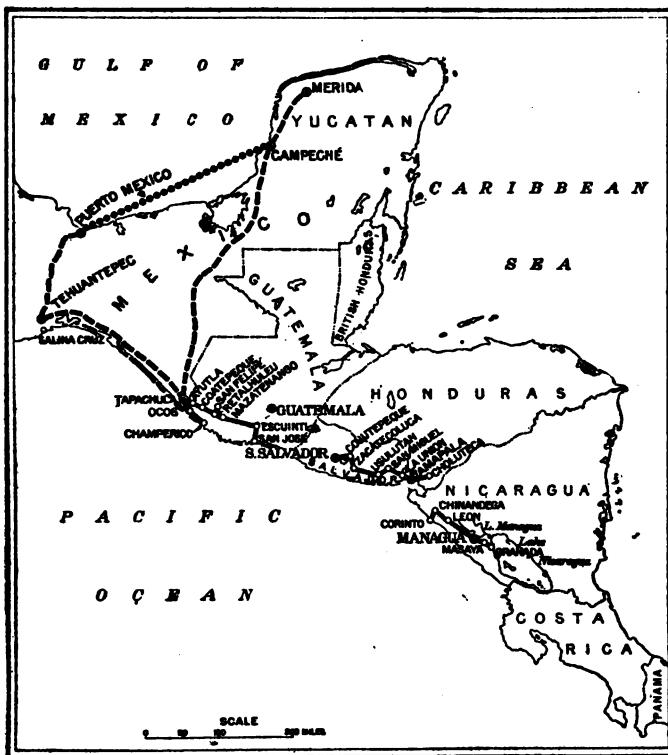


Fig. 69.—Epidemic route of yellow fever in Central America, 1918-1919. Broken lines indicate probable route of infection from Merida, Yucatan, into Guatemala. Solid line connects points visited by yellow fever in Central America.

mosquito. The last case occurred in December, 1918. Protective work was carried on by Government throughout the year 1919 in Pacific coast towns and in communities on or near the Mexican border, and there was no recurrence of the outbreak during the year.



Fig. 70.—Patio in tenement house district of Guayaquil, near center of city. Note large numbers of water containers. In nearly all of these, before control measures, yellow fever mosquitoes were breeding



Fig. 71.—Typical patio in outskirts of city of Guayaquil, Ecuador. The sanitary inspector (in uniform) is straining water through muslin to discover whether mosquitoes are breeding

Course of the Disease in Central America during 1919. Yellow fever was first detected in Central America during 1919 at Amapala (Fig. 69). Thence it spread to San Salvador and to Nicaragua. In the former republic thirty positive and ten suspicious cases of the disease were reported in San Salvador city; ten positive and several suspicious cases in San Miguel; and one case in La Unión. There were also reports of suspicious cases in other towns, as Quetzaltepeque, San Viviel, and Guayabal, but on investigation the rumors could not be verified. About 50 per cent of the bona fide cases died. In December a case of yellow fever in the person of an American who had come directly from Salvador, was detected at the New Orleans quarantine station.

In Nicaragua the disease first appeared in León about the middle of July, and a little later in Managua. The outbreak in this country has been attributed to refugees from the Honduran revolution. There were about 100 cases in León up to October 26, counting as positive all typical and highly suspicious cases. The cases up to August 10 were confined almost entirely to people from Matagalpa and the Segovias; until then, none of the cases at Leon had occurred among natives of that place.

In the latter part of August, Dr. C. A. Bailey, the Board's representative in Salvador, accompanied General Lyster and Dr. Pareja, two members of the Board's Yellow Fever Commission, on a visit of investigation to Amapala, Honduras. On arrival there the commission was informed that three persons had recently died with symptoms closely resembling those of yellow fever. On board the U. S. S. Chicago, at that time lying at anchor in the harbor, there were two positive cases in the early stages of the disease, both of which had undoubtedly received their infection while on shore leave in Amapala. Reports of suspicious cases had also been received from San Lorenzo, Pespore, and Choluteca. The last-named place could not be visited because of a revolution, but the commission on its visits to San Lorenzo and Pespore found no yellow fever in either place. In both, the Stegomyia index was low. The commission saw, between August 30 and September 6, the respective dates of its arrival at and departure from Amapala, a total of seven positive and several suspicious cases. There was one death. These cases were in addition to the three which were reported as having died, with typical symptoms, before the commission's arrival.

Creation of Yellow Fever Boards in Central America. The National Health Departments of Salvador, Nicaragua, and Honduras invited the Board's representatives to join with them in efforts to control the disease. As a result, sanitary inspection corps were organized and active campaigns against the Stegomyia mosquito were instituted in localities which either had been visited by yellow fever, or were in danger of being visited. The people co-operated heartily in the programs, and the outbreaks were quickly suppressed. The

last case was reported from Honduras in September, from Nicaragua in November, and from Salvador in December. Permanent local yellow fever boards have been organized in all these countries, as well as in Guatemala, and protective anti-mosquito measures are being continued under the supervision of commissions on which the International Health Board has representatives.

Recurrence of Yellow Fever in Brazil. During the first quarter of the year, yellow fever appeared in six of the northern states of Brazil. Reports from the state of Bahia, whose principal city is believed to be an endemic stronghold of the disease, indicated that there were many cases in that city during the year. In May and June two cases were discovered as far south as the city of Rio de Janeiro, both in persons who had recently arrived there from Bahia. Five cases were reported from Rio Grande do Norte during the year, two from Sergipe, five from Pernambuco, and an indeterminate number from Ceara (see map, Fig. 72).



Fig. 72.—Map of Brazil indicating, by cross hatching, states visited by yellow fever during 1919

being endemic. At the close of the year the infection seemed to be confined, in endemic form, to the coastal area between Bahia and Pernambuco. The last case was reported from Ceara in June, from Sergipe in August, from Rio Grande do Norte in September, from Pernambuco in October, and from Bahia in November. The work throughout the region was well in hand at the close of the year, and prospects appeared bright for the early, complete, and final elimination of the infection.

Appearance of the Disease in Peru. The frequent intercourse between Guayaquil (in Ecuador) and Piura, a city of 30,000 inhabitants in northern Peru, doubtless occasioned the mild epidemic of yellow fever which appeared in the latter region during the first half

Janeiro, both in persons who had recently arrived there from Bahia. Five cases were reported from Rio Grande do Norte during the year, two from Sergipe, five from Pernambuco, and an indeterminate number from Ceara (see map, Fig. 72).

Results of Control Measures Instituted by Brazilian Authorities. Operations against yellow fever were centralized under the newly reorganized Brazilian national public health service, and vigorous campaigns were instituted in all the northern localities in which the disease was suspected of

of 1919. Up to the middle of July there had been thirty cases with ten deaths. In addition to Piura, the port of Payta was affected. The newly created health service of Peru has undertaken control measures, and at the close of the year was prosecuting a vigorous anti-Stegomyia campaign.¹

Recrudescence of Yellow Fever in Mexico. Yellow fever in epidemic form had not been reported from Mexico for some years. In 1919, it was reported in the state of Yucatan, where in November it caused the death of two persons. The disease assumed epidemic tendencies and spread to the states of Campeche and Chiapas. Later a number of cases were reported from Manzanillo on the Pacific coast. The Mexican authorities notified the health officials of other countries of the presence of the disease, so that the latter might establish a protective quarantine.

¹ Later, May, 1920: Since February, 1920, yellow fever has occurred in at least ten places, with more than 250 cases reported. Work for the control of the infection continues in progress throughout the infected region.

X

PREVENTION OF TUBERCULOSIS IN FRANCE

The work of the Commission for the Prevention of Tuberculosis in France is carried out under four main departments: the medical department, which operates model dispensaries for the demonstration of working methods; the department of extension, which organizes and equips dispensaries in various provinces of the country; the department of nursing, which maintains training schools for public health visitors, and sends out these visitors to meet the ever-increasing demands of public health work; and the department of education, which organizes exhibitions, holds mass meetings, and distributes public health literature throughout France. The main activities of each of these departments during 1919 are summarized below.

WORK OF THE MEDICAL DIVISION

Under the direction of the medical division, the demonstration units in the 19th arrondissement of Paris and in the department of Eure-et-Loir were continued and developed; the work of dispensary organization was begun in three departments of the war-devastated area—Aisne, Marne, and Meurthe-et-Moselle; surveys were conducted in portions of five other departments; laboratory service in Paris and in Eure-et-Loir was centralized; and a graduate course in the theory and practice of treating tuberculosis was organized in co-operation with the Paris Faculty of Medicine and the physicians of the Paris hospitals.

Progress in the Department of Eure-et-Loir. During 1919 there were twenty-two dispensaries in operation in the department of Eure-et-Loir, eleven of which were opened after July 1. By the end of the year, two pavilions for advanced cases of tuberculosis were operating satisfactorily, and work was progressing on two additional pavilions and on a building which was being remodeled to serve as a sanatorium. With the opening of the three latter buildings, and of the two new dispensaries which are to be completed in January, 1920, the program adopted for the department will be practically in full operation.

Developments in the 19th Arrondissement of Paris. The important developments in the 19th arrondissement of Paris were the centralization of dispensary work at two dispensaries—the large new central dispensary, and a smaller one in another part of the arrondissement—and the appointment of a French physician as chief of dispensaries. The French physician succeeds an American. This change is in keeping with the established policy of replacing,

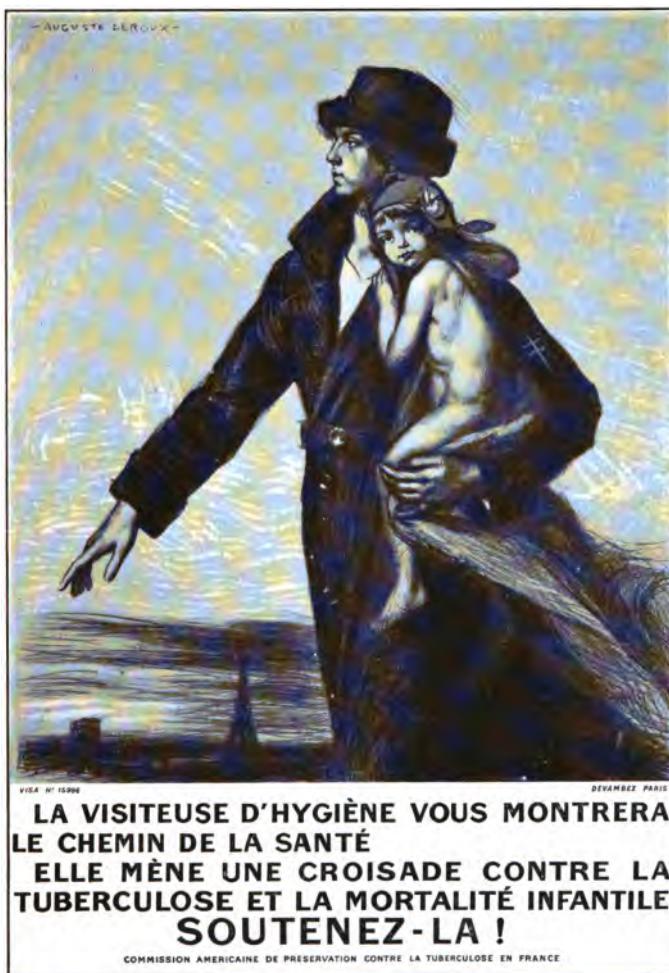


Fig. 72.—One of the posters used for creating interest in public health work in France



Fig. 74.—Taking health messages to the schoolchildren of France.

PREVENTION OF TUBERCULOSIS IN FRANCE 169

as soon as practicable, the American with French personnel. The staff of the Commission's medical service in the arrondissement is now entirely French.

Graduate Course for Physicians. A six weeks' training course in the diagnosis and treatment of tuberculosis, open to graduate physicians, was inaugurated on October 20 at the Faculty of Medicine in Paris. In addition to theoretical instruction, the course included practical work under specially qualified experts in hospitals and dispensaries. Twenty-eight physicians took advantage of the course during 1919. The Commission provided sixteen of these with full, and six with partial, scholarships. A similar course is to be given in April, 1920. Registration for this course is already in excess of the number of pupils that can be accommodated.

DEPARTMENT OF NURSING

During 1919, seven training schools for public health visitors were in active operation. All of these were under French direction, and all had teaching staffs almost wholly French. Altogether, 205 scholarships were granted in these schools, and fifty-one pupils were graduated. Through this department the Commission assigned seventy-six visiting nurses to various departments of France. The salaries of these nurses, at first paid by the Commission, are gradually being assumed by the local department authorities. At present these authorities are paying the full salaries of eighteen nurses, and portions of the salaries of nine others.

DEPARTMENT OF EDUCATION

The department of education continued its traveling exhibits, its distribution of literature, and its publicity in newspapers and magazines. By the end of the year the exhibits had visited twenty-eight departments of France. In each department large meetings were held at all the important centers; addresses were made by local authorities, by prominent physicians, and by the Commission's lecturers; films giving scientific and popular instruction in tuberculosis were shown; and literature was distributed to each member of the audience. Simple popular talks were also delivered to each class in all the schools in the cities visited. Punch and Judy shows with hygiene as their subject proved a popular feature of the propaganda work, and were particularly valuable in enlisting the interest of the children. In all, more than three million people were reached by the educational activities and more than three million pieces of literature were distributed.

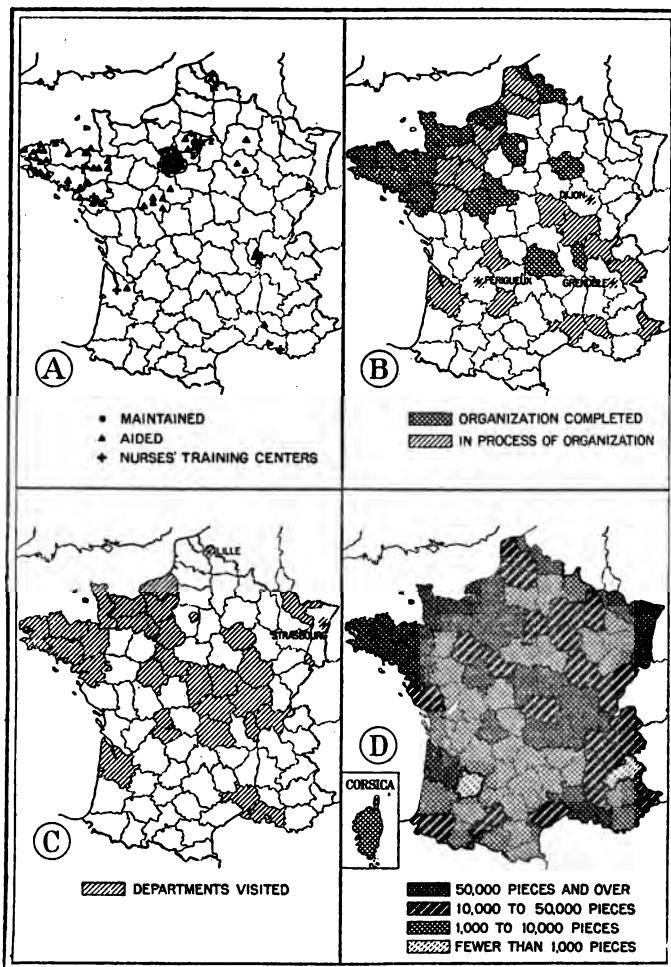


Fig. 75.—Organization and activities of Commission for the Prevention of Tuberculosis in France. A. Work of medical division and department of nursing, showing dispensaries maintained or aided and location of nurses' training centers; B. Work of division of departmental organization, showing departments in which anti-tuberculosis organization has been effected; C. and D. Work of educational division, C. showing departments visited by traveling exhibits and D. the number of pieces of literature distributed in each department

DEPARTMENT OF EXTENSION

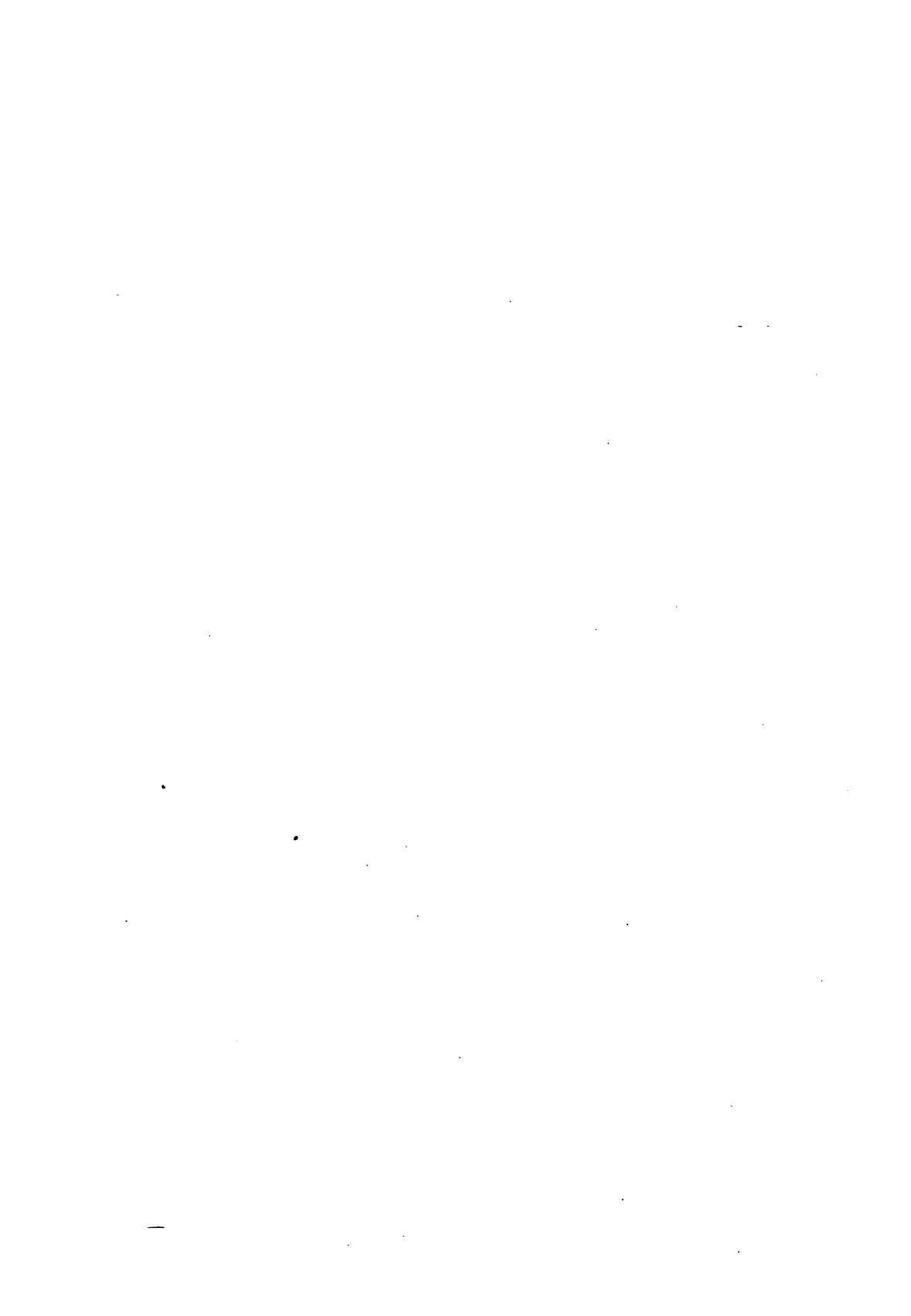
The efforts of the Department of Extension resulted in the organization, in fourteen departments of the country, of departmental committees for the control of tuberculosis. Preliminary work toward this end has been pushed forward in twelve additional departments. As one result of the work of the Department of Extension, forty-two new dispensaries were opened during 1919, thirty-six others were in process of construction at the close of the year, and plans were being perfected for fifty-two more.

SUMMARY OF WORK ACCOMPLISHED IN 1919

- 33 departments surveyed and organized.
- 14 departments organized during the year.
- 21 departmental tuberculosis associations formed.
- 75 new local tuberculosis committees formed.
- 48 local tuberculosis committees being formed.
- 56 new dispensaries opened in 1919, outside of Eure-et-Loir.
- 58 new dispensaries are in process of installation.
- 50 new dispensaries are immediately planned for.
- 60 new health visitors in the field, of which 35 are for dispensaries co-operating with the Commission.

1,866,200 Francs donated by the American Red Cross and the Rockefeller Commission for certain departments.

4,162,000 Francs raised and voted by the French in these same departments.



TABULAR SUMMARY

TABLE I: All Countries—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed During 1919, by Geographical Regions. Figures Excluded for Areas in Which Work Was Still in Progress

GEOGRAPHICAL REGION	CENSUS	MICROSCOPICALLY EXAMINED		FOUND INFECTED		GIVEN FIRST TREATMENT		CURED	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	...	...	...	...	...	237,434	..	130,236	54.9
Southern States ¹	26,226	10,255	39.1	9,380	91.5	225	2.4		
West Indies	20,637	14,537	71.4	13,534	93.1	10,347	76.5		
Central America ²	20,350	98.6	98.857	86,079	87.1	43,151	50.1		
South America (Brazil)	175,201	90.1	56.4	26,751	88.0	..			
The East ³	54,387	48,989	30,387	101,690	..	76,513	75.2		

¹ During 1918, in the Southern States, the main emphasis was placed on the building and improving of latrines.

² In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with other regions.

³ In Ceylon, throughout a large part of 1918, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "The East" and "Total."

TABLE 2: *Southern States—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed During 1919, by States. Figures Excluded for Areas in Which Work Was Still in Progress¹*

STATE	CENSUS	EXAMINED		INFECTED		TREATED		CURED	
		Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	...	26,226	...	10,255	39.1	9,380	91.5	225	2.4
Alabama	...	46	...	6	13.0	6	100.0	6	100.0
Georgia	38,911	1,518	3.9	373	24.6	336	90.1	107	31.8
Mississippi	27,510	16,036	58.3	8,479	52.9	8,471	99.9	6	...
South Carolina	...	4,966	...	1,057	21.3	327	30.9	...	...
Tennessee	8,857	378	4.3	17	4.5	9	52.9	3	33.3
Texas	4,573	3,044	66.6	322	10.6	230	71.4	103	44.8
Virginia	2,881	238	8.3	1	0.4	1	100.0	0	0.0

¹ During 1919, in the Southern States, the main emphasis was placed on the building and improving of latrines.

² Less than one-tenth of one per cent.

TABLE 3: *West Indies—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed During 1919, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress*

COUNTRY	CENSUS		MICRO-SCOPICALLY EXAMINED		FOUND INFECTED		GIVEN FIRST TREATMENT		CURED	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	20,637	20,359	98.6	14,537	71.4	13,534	93.1	10,347	76.5	
British Guiana	4,079	3,991	97.8	2,895	72.5	2,659	91.8	1,757	66.1	
Jamaica	2,935	2,842	96.8	1,552	54.6	1,346	86.7	1,058	78.6	
Saint Lucia	4,366	4,350	99.6	2,597	59.7	2,547	98.1	2,364	92.8	
Trinidad	9,257	9,167	99.0	7,493	81.7	6,982	93.2	5,168	74.0	

TABLE 4: *Central America—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed During 1919, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress*

COUNTRY	CENSUS Number	MICRO- SCOPICALLY EXAMINED Number	FOUND INFECTED Number	GIVEN FIRST TREATMENT		CURED ¹ Number	Per Cent
				Per Cent	Number		
Total	175,201	98,857	56.4	86,079	87.1	43,151	50.1
Costa Rica	72,075	64,371	89.4	29,872	46.4	26,551	88.9
Guatemala	46,220	44,495	96.3	28,752	64.6	25,283	87.9
Nicaragua	12,246	12,246	..	5,820	47.5	4,829	83.0
Panama	18,384	15,307	83.3	13,490	88.1	11,812	87.6
Salvador	42,967	38,782	90.3	20,923	54.0	17,604	84.1

¹ In Central America the bulk of the work is by the dispensary plan. This does not afford opportunity for frequent re-examinations to determine cure. Consequently the percentage of persons known to be cured is low in comparison with that for other regions.

TABLE 5: *The East—Persons Enumerated in Census, Microscopically Examined, Found Infected, Given First Treatment, and Cured of Hookworm Disease in Areas Completed During 1919, by Countries. Figures Excluded for Areas in Which Work Was Still in Progress*

COUNTRY	CENSUS		MICRO-SCOPICALLY EXAMINED		FOUND INFECTED		GIVEN FIRST TREATMENT		CURED	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Total	...	...	...	...	...	...	101,690	...	76,513	75.2
Ceylon ¹	...	...	...	...	...	...	88,602	...	69,032	77.9
China	2,025	2,025	100.0	100.0	937	46.3	848	...	1,359	...
Seychelles	10,824	10,801	99.8	99.8	6,924	64.1	6,702	96.8	6,122	91.3
Siam ²	...	...	...	...	...	...	5,538	...	...	...

¹ In Ceylon, throughout a large part of 1919, estate laborers were assumed to be infected, and accordingly were given first treatment without preliminary microscopic diagnosis. This explains the blank spaces for "Census," "Microscopically Examined," and "Found Infected" in the lines for "Ceylon" and "Total."

² First Quarter only.

FINANCIAL STATEMENT

TABLE 6: *Expenditures of the International Health Board During the Year 1919*

FIELDS OF ACTIVITY	AMOUNT EXPENDED
Grand Total	\$1,436,355.00
RELIEF AND CONTROL OF HOOKWORM DISEASE	511,011.10
MALARIA CONTROL	34,965.08
YELLOW FEVER CONTROL	94,526.42
TUBERCULOSIS IN FRANCE	602,775.78
PUBLIC HEALTH EDUCATION	38,367.71
PHILIPPINE HOSPITAL SHIP	6,500.00
INVESTIGATION OF SEWAGE DISPOSAL AT RURAL HOMES	778.60
FIELD STAFF SALARIES, EXPENSES, AUTOMOBILES, ETC., NOT PRORATED TO SPECIFIC BUDGETS	21,524.93
MISCELLANEOUS	47,598.71
ADMINISTRATION	78,306.67
 ITEMIZATION BY STATES AND COUNTRIES	
RELIEF AND CONTROL OF HOOKWORM DISEASE	511,011.10
Southern States	113,299.42
West Indies	48,457.24
Central America	111,684.19
South America	157,555.86
The East	80,014.39
Southern States	<u>\$113,299.42</u>
Administration	10,577.32
Alabama	5,283.74
Georgia	4,604.21
Kentucky	1,978.40
Louisiana	1,370.18
Maryland	2,264.25
Mississippi	15,773.21
North Carolina	13,924.04
South Carolina	14,754.86
Tennessee	10,201.59
Texas	22,380.20
Virginia	10,012.42
West Virginia	175.00
West Indies	<u>48,457.24</u>
Administration	4,624.50
British Guiana*	9,984.28
Dutch Guiana*	613.23
Jamaica	9,832.48
St. Lucia	8,109.32
Trinidad	15,293.43

*For administration reasons, British and Dutch Guiana, although on the mainland of South America, are considered West Indian Colonies.

TABLE 6: *Expenditures of the International Health Board During the Year 1919—Continued*

FIELDS OF ACTIVITY	AMOUNT EXPENDED
RELIEF AND CONTROL OF HOOKWORM DISEASE— <i>Continued</i>	
Central America	\$111,684.19
Administration	9,785.86
Costa Rica	20,492.01
Guatemala	19,514.73
Nicaragua	26,164.44
Panama	18,565.05
Salvador	17,162.10
South America	157,555.86
Brazil	155,430.38
Colombia	2,125.48
The East	80,014.39
Administration	3,619.43
Australia	15,902.95
Ceylon	32,497.87
China	12,187.58
Seychelles Islands	8,291.90
Siam	7,514.66
MALARIA CONTROL	\$34,965.08
Arkansas	13,505.66
Mississippi	21,167.37
Brazil	292.05
YELLOW FEVER CONTROL	94,526.42
Ecuador	48,396.77
Guatemala	967.82
Salvador	890.71
Salaries, Expenses, Equipment, etc. of Director and Associates	44,271.12
TUBERCULOSIS IN FRANCE	602,775.78
Central Administration	72,394.12
Medical Division	389,328.32
Educational Division	141,053.34
PUBLIC HEALTH EDUCATION	38,367.71
Department of Hygiene—Faculdade de Medicina e Cirurgia de São Paulo: Equipment	\$ 1,734.95
Operating Expenses	21,847.62
	23,582.57

TABLE 6: *Expenditures of the International Health Board During the Year 1919—Continued*

FIELDS OF ACTIVITY	AMOUNT EXPENDED
PUBLIC HEALTH EDUCATION—Continued	
Fellowships:	
Bello Horizonte Medical School	\$2,461.65
Czecho-Slovakian	2,858.66
Public Health	2,420.69
São Paulo—Department of Hygiene	3,020.89
Miscellaneous	2,356.58
University of Pennsylvania	\$13,118.47 1,666.67
MISCELLANEOUS	47,598.71
Analysis of Records of the United States Army in respect to Hookworm disease	43.95
Drugs for conserving Health of Field Staff	76.94
Medical Examination of Applicants of Field Staff	100.00
Field Equipment and Supplies	23,434.94
Surveys and Exhibits	16,870.71
Survey—Public Health Administration in Mass.	26.09
Pamphlets and Charts	5,499.50
Portable House for Salvador	476.19
Express, Freight and Exchange	1,070.39

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